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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST RESEARCH ACTIVITIES

FOREST MANAGEMENT
RANGE MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
FOREST SURVEY
FOREST INFLUENCES

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FOREST RESEARCH

BI-MONTHLY REPORT

October 1, 1939

FOREST RESEARCH

BI-MONTHLY REPORT

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CONTENTS

	Page
General	1
Forest Economics	
Forest Survey	4
Forest Taxation and Insurance	12
Private Forestry	15
Forest Management Research	
Forest Fire Protection	17
Forest Genetics	24
Mensuration	28
Regeneration	36
Silviculture	47
Forest Products	
Forest Products Statistics	61
Timber Harvesting and Conversion	62
Wood Preservation	65
Forest and Range Influences	
Flood Control Surveys	68
Influence of Natural Vegetation on Streamflow	75
Stabilization of Soils	83
Range Research	
Artificial Revegetation	86
Grazing Management	89
Cooperating Bureau Projects	
Entomology	104
Pathology	108
Publications	
Manuscripts	111
Station Notes	115
Forest Survey Releases	116
In Print	116
Translations	124

GENERAL

Allegheny

Personnel. Mesavage has transferred from the Flood Control Surveys to the Anthracite Economics Survey. Bevan accompanied Dr. Haig to the West Indies, leaving Stoddard in charge of the Flood Control Surveys. Huberman from the Washington office, and Mollenhauer, from the Central States, are on detail to assist in carrying the very heavy FCS work load.

Appalachian

Personnel. James W. Cruikshank was transferred from the Southern Forest Experiment Station, to work on the Forest Survey.

M. M. Riley, employed by Region 8 to work under the supervision of the Station, has taken over fire danger station inspection.

California

Personnel. The most important internal item of the summer was the transfer of J. A. Hall to become Director of the Central States Station. Dr. Hall has made a conspicuous mark at this Station during his two years here and his going is regretted.

Central States

Meetings. On June 17 Mollenhauer and Kellogg attended a meeting of the foresters engaged in the Ohio Woodland Survey at Dayton, Ohio. An afternoon panel discussion on "A Long Range Program for Ohio Farm Woods" included as speakers G. Y. Bell, L. F. Kellogg, O. A. Alderman, and R. F. Wilcox. At another meeting of the Ohio Woodland Survey personnel at Columbus on July 8, S. Duval Anderson, of the Milwaukee office of State and Private Forestry, and Kellogg led the discussion on "Volume Tables for Ohio." Other meetings of the Survey on July 29 and August 29 were also attended by Kellogg, Kuenzel and Day.

Chapman, a member of the Alumni Faculty of Ohio State University for 1939, delivered a paper on "A National Resource Rebuilt through Reforestation" before a group of alumni.

Intermountain

Wasatch Branch Experiment Station Field Day. The third annual Field Day at the Wasatch Branch Experiment Station was held on September 27 under the joint auspices of the Intermountain Forest and Range Experiment Station, the Wasatch National Forest, and the Davis County Planning Board. Approximately 40 Davis County residents were in the half-day tour which included an inspection of the Farmington Canyon experimental watersheds, current contour trench flood and erosion control operations, new recreational improvements, and artificial reseeding demonstration areas.

Lake States

Traveling Land-Use Conference. The Station participated in the field trip of U.S.D.A. and Land-Grant College officials through the Lake States during the last week of September. The party started from Detroit, traveling through southern Michigan, including a portion of the Manistee National Forest, thence across Lake Michigan and Wisconsin, visiting the Forest Products Laboratory at Madison. They then proceeded through southern and western Minnesota to the Red River of the North, thence through northern Minnesota and northwestern Wisconsin to St. Paul. The Chippewa National Forest, including the two experimental forests, and part of the Chequamegon were visited.

The Washington Office was represented by Mr. Clapp; Region 9, by Messrs. Price, Wilson, Murphy, and Ochsner; and the Station, by Zon, Moser, and Eyre.

Although agricultural land-use planning, and particularly county planning, was emphasized, forestry could not be kept out of the picture.

Comments from members of the party brought out the need for greater utilization of wood-lot products by established industries in southern Michigan, the urgency of sandblow control east of Lake Michigan, and the need for windbreak planting in western Minnesota. The Chippewa National Forest was an agreeable surprise to many who expected to find only waste land in northern Minnesota. The reforestation enterprise as seen on the Chequamegon seemed to have general approval as one definite step in the rejuvenation of the "cutover area."

Field Days. The experimental forests and centers of work continue to be intensively used for demonstration purposes. The silvicultural methods of handling red and jack pine were emphasized in a field day held on August 28 on the Chippewa National Forest, for members of the Indian Service. On the following day, the possibilities in the management and conversion of aspen were pointed out to the group of men from the Indian Service, as well as to members of the technical staff of the Chippewa National Forest.

At the Nicolet center of work in Wisconsin, the Station cooperated with the Division of State and Private Forestry, Region 9, in conducting a nursery and planting field trip for the benefit of private foresters and State employees in Wisconsin. The need for plantation care was stressed on this field trip.

Personnel. Shirley, after ten years in the Lake States, has been appointed Director of the Alleghany Forest Experiment Station. Shirley joins the list of distinguished alumni of the Lake States Station.

Pacific Northwest

Meetings. The annual meeting of the Forest Research Council of the Pacific Northwest was held at the offices of the Experiment Station September 19, 1939. Prior to the meeting several committees of the Council had been set up, each one to examine into specific portions of the Station program and to report its findings and recommendations to the Council as a whole. The meeting of the Council consisted primarily of the reports of these committees with subsequent discussion of the Station program. It was felt, both by the Council and the Station staff, that the committee system was very successful, and as a result the Council voted to maintain the committees throughout the year. Members of the Station staff will confer with these committees whenever recommendations or advice is desired.

Southern

Personnel. John R. Curry was transferred July 1 from the California Station to the Southern to head up the Station's Division of Forest Management.

FOREST ECONOMICS

FOREST SURVEY

Appalachian

Depletion

The North Carolina census of lumber production for 1938, made in cooperation with the Bureau of the Census, has been completed and the data forwarded to the Census Bureau for tabulating.

The Survey figures for 1937 lumber production for North Carolina have been tabulated by mill capacity classes and show some interesting comparisons.

North Carolina -- 1937

Number of sawmills operating and production by size class of mill

Size of mill (Daily capacity) (10 hours)	Number mills	Lumber production			Percent of total
		Pine	Hardwood 1/	Total	
		- Millions of board feet -			
1 - 9 M	2,867	824	202	1,026	66
10 - 19 M	123	131	62	193	13
20 - 39 M	47	146	89	235	15
40 M & over	6	70	27	97	6
	3,043	1,171	380	1,551	100

1/ Includes 30 million board feet of cypress and white cedar.

Two-thirds of the lumber produced in the state was cut by mills of less than 10,000 board feet per day capacity. Pine species made up three-fourths of the total cut.

Reports

The first two Survey releases of the Appalachian Station, "The forest resources of the northern coastal plain of South Carolina" and "The forest resources of the Piedmont region of South Carolina", were issued in August and September. A third release covering the remaining unit in South Carolina, the southern coastal plain, has been prepared jointly by the Appalachian and Southern stations and is ready for processing.

Similar releases for the two coastal units of North Carolina are approximately 60 percent completed.

Lake States

Census of Wisconsin Sawmills, 1938. As a result of the cooperative agreement between the Station and the U. S. Census, the 1938 production for sawmills, lath mills, and shingle mills has been estimated. In the following table a comparison of the Forest Survey estimate of production and number of mills for 1936 and 1938 is shown.

Comparison of the Forest Survey Estimate of Lumber, 1/
Lath, and Shingle Production
Wisconsin, 1936 and 1938

Sawmill class	Estimated normal production	1936		1938	
		Number of mills	Production	Number of mills	Production
1	Over 25,000 M ft.b.m.	8	165,830	5	128,370
2	5,000 to 25,000 M ft.b.m.	12	143,322	11	104,754
3	1,000 to 5,000 M ft.b.m.	57	100,051	53	66,160
4	500 to 1,000 M ft.b.m.	67	45,017	65	32,284
5	50 to 500 M ft.b.m.	558	87,686	543	73,449
6	Under 50 M ft.b.m.	836	15,302	819	14,477
All sawmills (M ft.b.m.)		1,538	557,208	1,496	419,494
Lath mills (M pieces)		35	22,411	47	20,774
Shingle mills (M pieces)		85	77,629	89	37,271

1/ Lumber production includes sawed ties.

This summary was made to obtain a production estimate for 1938 comparable to the 1936 Forest Survey estimate, and will not agree with the Census for we have included estimates for mills omitted from the Census list but which from our records would seem to be still operating; also, operators idle in 1938 but still in the business were included. An estimate has also been made of the production of mills producing less than 50,000 feet annually which are omitted from the Census list.

Kansas Survey Report. The "Woodlands of Kansas" by E. R. Ware and L. F. Smith, the second forest survey report for the Great Plains region, was issued by the Kansas Agricultural Experiment Station in July. The forest survey project upon which the report was based was supervised by the Lake States Forest Experiment Station.

Table 1 shows the extent of native timber, and table 2 the number and size of plantations.

Table 1.--Area, Volume, and Growth of Native Timber in Kansas

Species	Area	Saw-timber volume 1/		Average annual growth 2/	
		Per acre	Total	Per acre	Total
	Acres	Bd.ft.	M bd.ft.	Bd.ft.	M bd.ft.
Mixed hardwoods	904,000	2,285	2,065,360	82	74,525
Cottonwood	107,000	3,170	339,040	182	19,455
Blackjack post oak	62,000	200	12,400	13	777
Total	1,073,000	2,252	2,416,800	88	94,757

1/ Scribner log rule.
2/ For the decade 1937-46.

Table 2.--Number and Acreage of Plantations in Kansas, 1936

Kind of planting	Number	Percentage of all farms or schools provided	Acres of plantation
Field planting 1/	51,020	29	123,600
Farmstead windbreak	29,500	18	24,600
Farm wood lot	4,800	2.7	16,600
Schoolground planting	680	8.6	200
Total	86,000		165,000

1/ Includes 620 plantations totaling 5,000 acres established by the Prairie States Forestry Project up to 1936.

Northern Rocky Mountain

Inventory

Three 2-man crews completely mapped Ravalli County during the period July 24 to September 27. In this work base maps showing detail, principal topographic features, and the boundaries of the more pronounced land use types were built up in the office from aerial photographs. These base maps were very helpful to the field men in making their final map showing the boundaries of type, stocking, age, and site classes.

As a result of the summer's work the compilation of survey data in Lincoln County, Montana, is approximately 60 percent completed.

Since July 1 the draftsmen have completed 2"-to-the-mile township maps on an area of 968,000 acres and in addition have completed 1"-to-the-mile unit maps on 2,217,000 acres.

Growth

Girard and an assistant established 140 one-fifth acre plots in the ponderosa pine type in western Montana to determine the current growth per acre per year for this timber type. The final result of this study was a curve showing, for stands of different degrees of stocking, the ratio between actual stand

growth and growth of fully stocked stands of the same age and site as shown by the normal yield table. The ratios between actual growth and normal yield table growth by percentage of normal stocking (on a basal area basis) are as follows:

Percent of stocking	Percentage actual growth is of normal
30	53
40	65
50	75
60	83
70	89
80	94
90	98

Pacific Northwest

Growth Data. Further calculations of the original growth data have been made to determine the relationship of current annual growth to potential annual growth on lands which should be supporting growing forests. Previous calculations of potential annual growth were made for all commercial forest lands, including areas not occupied by virgin timber. These calculations show that for the Douglas fir region as a whole current annual board-foot growth is a little more than half of potential annual growth on land exclusive of that occupied by virgin timber. Analysis of these data by units and counties discloses a much greater difference in certain units and counties. For example, in Columbia County, Oregon, using the revised inventory data, current annual growth was estimated to be 22.4 million board feet compared to a potential annual growth on the area that should be supporting growing stands of 139.6 million board feet. In cubic feet the current annual growth was 19 million cubic feet and the potential 40.8 million cubic feet.

Douglas Fir Report. Comments of Timber Management were received from Washington, checked, and answered. The most important points were discussed with Carter personally. Numerous other minor adjustments were made in the report.

Ponderosa Pine Reports. Results of the supplemental analysis of the pine volume data were published in mimeographed form as Forest Research Notes No. 28, "Volume Distribution in Saw-Timber Types in the Ponderosa Pine Region." Distribution of this publication was held up for several weeks by the necessity of verifying our mailing list to comply with new postal regulations regarding the distribution of reports and other published material under frank.

Sustained Yield Capacity of the Ponderosa Pine Region. Using the basic data derived from both the inventory and the growth phases of the survey, the adequacy of the timber supply in the ponderosa pine region has recently been analyzed to clarify the future of the forest industries. One step in the analysis involved the computation of sustained yield capacity, i.e., the volume of timber that could be cut annually without interruption or substantial future reduction.

It was found that if future curtailment of production is to be avoided, the current regional cut from ponderosa pine types should be limited to 941 million board feet annually.

This is the estimated production that these types can sustain over an initial cutting cycle without reducing their future productivity, if past cutting practice continues. The allowable cut for the pine types is 86 percent of the average saw-timber production of all species in the region for the period 1925-36, inclusive, and only 57 percent of the rate for the year 1937. Virtually, all cutting has been in the pine types.

The cut allowable under sustained yield can be materially increased by two means; first, by changing practice to a light selection system, second, by cutting in the non-pine saw-timber stands. By cutting on a maturity selection basis and removing in each cycle only 50 percent of total volume per acre, the allowable cut for the pine types is increased 18 percent, totaling 1,107 million board feet. An increased cut is justified under a system of lighter volume per acre removal owing to the increased speed with which virgin forest is converted to a condition of net growth and the saving that is made in mortality thereby.

The allowable annual cut from the non-pine saw-timber types is 396 million board feet, but until there is greater assurance of their ultimate economic accessibility and utilization they can be given little weight in balancing the timber budget. Detail of allowable cut for the various units together with recent sawlog production and ultimate sustained yield capacity are summarized in the following table.

Sawlog production 1925-1936, 1937, theoretical allowable cut under sustained yield 1935, and ultimate sustained yield capacity on available lands

Unit	Annual sawlog production						Ultimate sustained yield capacity	
	Average 1925-1936	1937	Allowable, cutting cycle beginning with 1935					
			Ponderosa pine types			Types other than ponderosa pine	Ponderosa pine sites	Sites other than ponderosa pine
			1/ 50-50	2/ 75-50	3/ 95-75			
	Million Bd. ft.	Million Bd. ft.	Million Bd. ft.	Million Bd. ft.	Million Bd. ft.	Million Bd. ft.	Million Bd. ft.	Million Bd. ft.
Chelan-Colville	123	145	135	129	118	117	224	171
Yakima River	124	159	117	113	106	120	152	181
North Blue Mountain, Washington	4	7	8	8	7	12	18	18
Total	251	311	260	250	231	249	394	370
North Blue Mountain, Oregon	82	94	100	95	87	65	166	91
Deschutes River	232	301	194	185	166	35	210	39
South Blue Mountain	109	237	213	203	187	27	290	47
Klamath Plateau	416	694	340	322	270	20	344	42
Total	839	1,326	847	805	710	147	1,010	219
Region total	1,090	1,637	1,107	1,055	941	396	1,404	589

1/ This is the allowable production under sustained yield if cutting in the ponderosa pine types during the period 1935-64 takes the form of light selection, removal averaging 50 percent of virgin stand volume per acre on all areas where cutting occurs.

2/ This is the allowable production under sustained yield if cutting in the ponderosa pine types takes the form of heavy selection, removal averaging 75 percent of virgin stand volume per acre on privately owned lands, 50 percent on other lands.

3/ This is the allowable production under sustained yield if cutting in the ponderosa pine types takes the form of virtual clear cutting, removal averaging 95 percent of virgin stand volume per acre on privately owned lands, 75 percent on other lands.

Southern

Computation

Plot volumes were summarized by county for the 27 pine units, and pine site indices were summarized by 100-plot sections of line for all units in Florida and Alabama. The following checking of reports was done:

First checks	Second checks
Alabama #5	Arkansas #1
Alabama #6	Alabama #3
Georgia State	Alabama #4
Louisiana State	

Summary naval stores tables for 1937-38 were prepared for the South.

Growth calculations included:

1. Estimates of increment in cords for 1935, 1936, and 1937 for Louisiana units.

2. Increment estimates for 1937 completed for Georgia #1, #2, and #3.

3. The growing stock for the Florida Survey units were projected to the year 1945 and estimates of increment and mortality made for the year 1944.

Depletion

Cooperation of the Southern Station with the Bureau of the Census in collecting forest products statistics for the lower South was inaugurated this year. Field forms (for sawmills only) were mailed by the Census from Washington and returned through the Station. The Station edited the forms, transcribed the production information, and carried out the field follow-up work. Altogether, 702 forms were received by mail, while 693 were secured in the field canvass. A total of 1939 mills in the State were accounted for after the field canvass was completed. A complete list of these sawmills, arranged alphabetically, was typed and a copy sent the Census.

Drain estimates for 1937 have been completed for the State of Georgia and Mississippi Unit #4; estimates for other units are being prepared. Employment data and industrial lists were also prepared for Georgia, Louisiana, and Florida. Industrial lists

for 1937-38 were also prepared for each unit by counties, except the Mississippi Survey units; lists by counties for these units will be prepared soon. The data on these lists will be included in a revision of Forest Survey Release #25.

Reports

Delta. Winters' release on the "Forest Resources of the South Arkansas Delta" has been multilithed and is ready for mailing.

Ward completed going over the Louisiana State reports with the Computing Section after the first check. The report is now ready for editing.

Pine-Hardwood-East. Forest Survey unit reports for Georgia Units #4 and #5 were mailed. The report for Alabama Unit #3 is ready for multilithing, while the report for Alabama Unit #4 is being given the final check. Unit reports for Alabama Units #5 and #6 have been returned by reviewers and are ready for second checks.

Ineson and Ward have begun preparation of the State report for Alabama, and a first draft of a unit report for Mississippi Unit #2 is being prepared.

Naval Stores. The revised report on the south Georgia Survey units has been resubmitted to Washington. The last chapter of the State report for Georgia was completed by Eldredge and the report submitted to Raber for editorial check. Ineson continued to work on the State report for Florida.

FOREST TAXATION AND INSURANCE

Pacific Northwest

Taxation

Statistical data with reference to the operation of the reforestation tax laws of Oregon and Washington were obtained for the annual revision of Progress Report No. 16 and Tax Systems of the World. Other information on the operation of these laws was also reported. About 20 percent of the land area eligible for classification under the Oregon reforestation tax law is classified and the law has been in operation about 10 years. In Washington only 5 percent of the eligible area is classified and the law has been

in operation about 10 years. In Washington only 5 percent of the eligible area is classified and the law has been in operation about 8 years. In Oregon the State Forester has taken the lead in proposing lands for classification, while in Washington the initiative rests with the forest owner who must make an application to have his lands classified and subject to the yield tax. In Oregon about 14½ percent of the lands classified have subsequently been removed from classification while in Washington less than ½ of 1 percent of the classified acreage has been declassified.

The local government adaption study in Stevens County, Washington was continued in September after having been temporarily laid aside in April. During this period a large part of the county has been made a part of the Kaniksu National Forest.

DeVries spent two weeks at the California Station in July assisting in the preparation of the report for the land use study of the Sierra Nevada foothills.

Southern

Taxation

Considerable modification of the field technique of Craig's forest tax index project from the tentative technique reported in the April 1939 issue of the Bi-monthly Report (p. 10) has been found necessary. Following completion of field work in three Mississippi counties, present field technique has been standardized as follows, at least for the work in Mississippi:

Only two or three major forest types are recognized - pine, upland hardwoods, and bottomland hardwoods, although in two of the three counties thus far covered the hardwood types have been combined. Only three condition classes are recognized: (1) sawlog-size old growth or second growth, (2) under-sawlog-size second growth, (3) reproduction or clear-cut. Through cooperation of the Division of Highway Planning of the Mississippi Highway Commission we have been able to obtain copies of a base map of each county (scale 1" = 1 mile) showing all roads, railroads, towns, streams, lakes, and other important features superimposed on the sectionalized public land survey. With this map as a guide, the investigator travels a majority of the roads of the county, including back roads, selecting at random, and without prior knowledge of ownership, sample properties which he considers representative of the forest types and conditions occurring in the given county. Such selection is preceded, however, by a quick reconnaissance over the county to familiarize the investigator with the occurrence of forest land in relation to other land uses,

and with the forest types and conditions present. Since in the interests of accuracy of results it is desirable to have each sample property consist of only one type and condition-class, the samples generally do not exceed 160 acres in area, and in no case are they less than 40 acres. At the time of selection, each sample is located on the map in reference to the sectionalized public land survey and is classified by type and condition-class.

When a sufficient number of such properties has been selected to give adequate geographical distribution and a distribution by types and conditions roughly approximate to the distribution of all forest land in the county by the same criteria, the list is then taken to the county Court House where it is checked against the 1938 Land Roll. At this time the ownership of each sample is noted and such samples as are owned by the State or are otherwise tax-exempt are deleted from the list. In two of the three counties so far studied, properties partially tax-exempt under the terms of the Homestead Exemption Act of 1936 (as amended in 1938) were also deleted from the sample list. In the other county, however, they were included because the majority of the privately owned forest land in the county fell within the purview of the Homestead Exemption Act. In this latter county, however, taxes upon the homestead-exempt properties were computed on the same basis as in the first two counties, that is, without reference to the exemption granted by the Act. At the same time that ownership is checked, data are obtained on the assessed value of the sample properties (including, however, the value of unimproved land only) and on their location in respect to school, road, and other taxing districts. From these data, and by reference to the official levy order of the county Board of Supervisors for 1938, the total taxes on each property are computed. The properties are then sorted by type and condition-class and the average assessed value per acre, average tax rate, and average tax per acre computed for each type and condition-class separately. This completes the work for the 1938 taxes.

In order that a start may be made toward the ultimate aim of the whole study, namely, the development of a series of index numbers of the taxes per acre on forest land, data on the taxes for 1936 and 1937 have also been obtained. This is done by obtaining the assessed values of the same properties from the 1936 Land Roll (in Mississippi, real estate is assessed biennially in the even years) and by reference to the tax-levy orders for 1936 and 1937. It is assumed in this case that there has been no change in type or condition-class in the 3-year period. This assumption, however, will not be carried into the future; it has been tentatively agreed that either these same properties will be checked biennially as to their classification, or that at 2-year intervals an entirely new sample will be selected. Final decision on this point has not been reached.

Thus far, three counties have been studies in Mississippi: Marion, in the longleaf-slash pine type; Newton, in the shortleaf-loblolly pine-hardwood type; and Alcorn, in the upland hardwood-shortleaf pine-hardwoods types. The next county to be studied will be Quitman in the Delta bottomland hardwood area.

PRIVATE FORESTRY

Allegheny

Anthracite Survey. With the appropriation made by the 76th Congress, the Station has begun a survey of present and future opportunities for forest employment in the Pennsylvania anthracite coal region. This region embraces a gross area of about 8,000 square miles, over most of which the forest stock has been severely depleted by cutting and repeated burning. General economic conditions have been very bad during the last decade, due only in part to the current country-wide depression. A broadening of the economic base seems essential, and the possibility of developing a permanent forest industry appears not too remote. Prior to the selection of a project leader and the remainder of the technical staff, Mesavage has been assigned to the preparatory stages of the study.

Central States

The four-month period was devoted to gathering data for the Woodlands Economics Study in Illinois. This study is conducted under joint agreement with the Illinois Agricultural Experiment Station and the Illinois State Natural History Survey.

The major emphasis of the study is upon the estimate of growing stock and growth rates for individual woodlands and combinations thereof, upon appraisal of farm buildings and their state of repair and the use of homegrown forest products, upon evaluation of the productivity in both open and wooded pastures, and an appraisal of market and milling facilities for local stumpage.

The counties in which the field work was done are Boone (dairying), Bureau (livestock and grain), Fulton and Schuyler (general farming). A number of townships were selected within each of these counties and from each of these townships at least two farms were picked at random for study.

The field work was completed at the beginning of September and the temporary field force released. The data are being put in shape for punch cards where analysis will be aided by such procedure.

Lake States

Forest Cooperatives. A federation of forest-product cooperatives is visualized for the northern part of Wisconsin, if the cooperative organized in Washburn County for the purpose of furnishing work for the farmers living adjacent to the county forests proves to be successful.

The association will make sales contracts with wood-using industry after securing individual contracts from the members to deliver a certain type of product at a specified place and time.

The contracts, being negotiable, may be used to borrow up to 50 percent of the value of the product. The cutters may then be financed by paying them one-half the value of their product upon delivery to the landing. The balance of their earnings will be paid when payment has been made by the wood-using industry and all association expenses deducted.

Northern Rocky Mountain

Attendance at committee meetings and preparation of material for the Idaho and Montana state farm forestry plans, has absorbed about three weeks of Davis' time in September. Preparation of the two plans is well along but the working out of the details of investigative projects that may possibly be undertaken still remains. There is not much farm forestry actually practiced in either state and the major need at present seems to be for a better factual knowledge of exactly what part farm forestry does and can play in the farm economy. Economic dependency studies have been recommended as a starting point.

FOREST MANAGEMENT RESEARCH

FOREST FIRE PROTECTION

Allegheny

Behavior

The detailed fire weather study started in November, 1938. For forecasting purposes the effect of location upon instrumental readings of wind velocities and relative humidities are being studied. Three stations were set up, one above the tree tops on a standard weather tower, one on the ground in a small clearing, and one also on the ground but in the woods. The wind velocity data recorded between November 1, 1938 and May 31, 1939 at the three stations are averaged as follows:

Effect of Location of the Instruments and Condition of the Vegetation on Wind Velocity

Period	Station	Height of Anemometer Cups Above Ground	Average Wind Velocity (M. P. H.)		
			4 p.m. to 10 a.m.	10 a.m. to 2 p.m.	2 p.m. to 4 p.m.
Cured (November 1, 1938 to May 6, 1939, Inclusive)	Tower	52 ft.	6.38	9.53	9.17
	Open	7 ft.	2.53	5.02	4.67
	Woods	7 ft.	1.19	2.68	2.36
Transition (May 7, 1939 to May 21, 1939, Inclusive	Tower	52 ft.	5.40	8.11	8.91
	Open	7 ft.	1.85	4.12	4.48
	Woods	7 ft.	0.87	2.24	2.24
Green (May 22, 1939 to May 31, 1939, Inclusive)	Tower	52 ft.	4.68	7.78	8.54
	Open	7 ft.	1.33	3.25	3.58
	Woods	7 ft.	0.37	1.41	1.34
All Periods (Nov. 1, 1938 to May 31, 1939, Inclusive)	Tower	52 ft.	6.23	9.34	9.12
	Open	7 ft.	2.43	4.87	4.60
	Woods	7 ft.	1.13	2.58	2.30

During the period when the vegetation was in the cured state, about half as much wind movement occurred in the woods as in the clearing, and half as much in the latter location as on the tower. From the data so far available, it would appear that the ratio of differences among the stations increases materially when the leaves on the trees reach full size. Thus it would seem probable that at least two factors, location of the instruments and condition of the vegetation, will prove to have a statistically significant influence on the wind velocity recorded. Relative humidity records indicate no significant differences among the three stations.

Effects

A revised working plan for the cooperative controlled burning study has been written. The chief changes involve the taking of less intensive measurements, and setting up a definite time, subject to the occurrence of a good pine seed year, when treatment on half of each block will be discontinued to allow for the establishment of natural pine reproduction.

Appalachian

Fire Danger Measurement. A fire danger meter adapted for use in shortleaf-loblolly-hardwood forest types of the Piedmont and Coastal Plain has been developed and is now ready for field trial. Fuel moisture as indicated by wood sticks and days since rain, wind, and condition of vegetation are combined on the meter in five danger classes. As in the Appalachian mountain-type meter, provision is made for predicting danger 24 hours ahead. Tests show that the Coastal Plain meter will forecast correctly 80 percent of the time.

There are now 160 fire danger stations using the Appalachian meter and 55 more are to be established in the next two or three months. That considerable progress has been made in standardizing methods of rating danger is emphasized by the fact that 16 national forests, 24 national parks or memorials, 9 state organizations, 1 Indian reservation, and other Federal and private agencies are now using the same system.

Jemison has completed a detailed handbook describing the general philosophy and use of fire danger measurement systems. The booklet contains a description of instruments with prices and complete instructions for setting up and operating a fire danger station in the East. This is to be processed by the Station.

Fire Damage. A joint committee of Region 8 fire officials and members of the Southern and Appalachian Stations has been working on a technique of fire damage appraisal. In the South and East nearly every state has its own system of appraising damage and no

two of them agree. The job of the committee is to propose a standard method that can be used by state, private, and Federal fire control agencies.

The tentative system now being considered utilizes forest Survey statistics. For each forest type, condition class, and character of stand, volumes and forest value tables are determined. The percentages of stands killed by fires of different intensities and the effect of these fires on growth and cull are applied to the forest value tables to get tangible damage. Fire intensities are to be correlated with fire danger classes so that this factor can readily be allowed for in appraising damage. A system for including intangible damage has not yet been worked out.

Detection

Byram's eyesight test for forest lookout men has been completed and the distance that an individual can see the target used in the test can now be translated into his ability to see smoke. This relation, which depends on visibility distance, follows:

Visibility distance from haze meter	Ability to see eyesight target (feet): 80	100	120	140	160	180
Miles	Distance that individual can see standard smoke Miles					
2	2.7	2.8	3.0	3.1	3.3	3.4
4	4.3	4.6	4.9	5.1	5.3	5.5
6	5.7	6.1	6.4	6.7	7.0	7.3
8	6.9	7.5	7.9	8.3	8.6	8.9
10	8.0	8.7	9.2	9.7	10.1	10.5
12	8.9	9.7	10.4	10.9	11.5	11.9
14	9.8	10.7	11.4	12.1	12.7	13.2
16	10.7	11.6	12.4	13.2	13.8	14.5

An interesting lead has developed in the eyesight study but unfortunately we cannot follow it. Fifty or sixty individuals have been tested by the device and without exception the local men on relief have much poorer scores than others. It is a well known

fact that "night blindness" is caused by a vitamin deficiency and it is entirely probable also that the unbalanced diet of mountain people in this vicinity may be responsible for their inability to see the test target. The test rates ability to see contrast (not detail) and the reference to "night blindness" is thus even more interesting.

Compilation of three years of haze meter readings taken at 50 lookout stations in the Appalachian Mountains has shown the normal existence of significant differences in visibility distance from one forest to another. Such differences are important in detection planning where a radius of vision must be adopted in seen-area mapping. That a uniform radius for all forests should be avoided in some cases is shown by the following average visibility distances of standard-sized smokes:

National forest	Average visibility distance
	Miles
White Mountain	7.0
Jefferson	6.3
George Washington	5.4
Monongahela	4.7
Cumberland	3.0

California

Rate of Spread. At Pilgrim Creek Nursery, Shasta Experimental Forest, rate of spread of surface fires in ponderosa pine needles is being studied in the large wind tunnel recently constructed for this purpose. The tunnel has proven quite satisfactory and allows precise control of wind velocities up to about 15 miles per hour. The needles are burned in prepared beds and the rate is observed at which the flame spreads from the point of origin of the fire. To date, data have been recorded on 150 of these small experimental pine needle fires with wind velocity varying from 0 to 12 miles per hour, moisture content of the fuel varying from 4 to 15 per cent, and with the incompactness of fuel varying from 0.06 to 0.16 for the ratio of voids per surface area. This year slope is being held constant at zero. The results are closely reproducable and very promising. They indicate that relatively simple relations exist between the radial spread of the fire and the above three independent variables. Also it is indicated that for a fuel of constant particle characteristics and of zero slope, no more than these three variables; wind, fuel moisture, and fuel incompactness, need be included to obtain a very high correlation index.

Pine needles represent the simpler, commonly available, natural fuel. It is hoped that with a thorough understanding of the phenomenon of open air combustion under these simple conditions, similar techniques can be extended to the study of fires in naturally heterogeneous and more complex fuels such as brush. In anticipation of this extended study, northern brush fields are being investigated at this time by ascertaining on sample milacre plots the density of all component parts of the brush, (stems, twigs, leaves, etc., dead and alive) at various phenological stages. The purpose of this detailed study is a clear understanding of what constitutes the fuel in a brushfield and how it can be quantitatively expressed in fire behavior.

Soil Sterilization. The fifth annual inspection of soil sterilization plots has been completed. It was found that in the absence of erosion, plots treated six years ago with four pounds or more of arsenic trioxide per square rod are still almost completely barren of annual vegetation. On plots similarly treated in the same year with sodium arsenite some annual vegetation is now returning. Thus sterilization with dry white arsenic is proving to be of longer duration than sterilization with soluble sodium arsenite.

Where sodium chlorate was used on soil sterilization plots and backfiring lanes through bear clover, very nearly all the bear clover was killed and the soil is still practically free of this species. After five years the bear clover has spread into the poisoned area less than seven inches. This spread seems to be by root extension rather than by reseeding.

Much time has been spent on an analysis of the combined soil sterilization data of the Botany Division at Davis and of this Experiment Station in order to evaluate the influence of the soils upon the sterilizing effectiveness of the chemicals. The analysis is not yet complete but it has been shown that the effectiveness of two forms of arsenic upon annual vegetation is significantly influenced by the clay content and by the pH of the soil.

Lake States

Living Firebreaks. The Station, in cooperation with the Michigan Department of Conservation, is formulating plans for the establishment of hardwood firebreaks in pine plantations.

It has been noted that fires crowning in conifers are knocked down and become surface fires when they reach a hardwood type. If hardwood strips can be established in pine plantations, the disastrous crown fires, like those that occurred in northeastern Michigan last spring, may be fought successfully as surface fires, on which present protection equipment is fairly effective.

Questions to be answered are: How best to establish the hardwood strips, the species and width of strips most effective for the purpose.

Eagle River Fire-Weather Station. During the summer a permanent fire-weather station was established at the Region 9 Forest Officers Training Camp at Eagle River, Wisconsin, in cooperation with the Regional Office, to provide: additional fire-weather data for the Nicolet National Forest, for demonstration purposes, and to serve as a field base for fire-weather investigations in the Lake States. In addition to the station at Eagle River, temporary field stations were established at three nearby points to study the modifying effect of cover type on the moisture content and rate of drying of typical fuels.

Northern Rocky Mountain

Beginning July 1 the regional office provided a year's salary and expenses and assigned C. K. Lyman, a fire scout of long experience, to the station to commence the long needed detailed measurements of actual rate of spread of fire in each fuel type under the different conditions from class 2 to class 6 danger. So far Lyman has obtained measurements on some 33 test and spot fires. He will also verify fuel type ratings and danger class data for an equal or greater number of actual fires as reported by dependable smokechasers on form 929. During the winter an analysis will be made of the coded data for all fires since 1930 for which the essential items were recorded on the punch cards. This large volume of data, checked by the accurate test and spot fire measurements, should serve to show the form and entire length of the rate-of-spread curve for each fuel type throughout the entire range of danger class. Future research work can then be better designed to correct those major discrepancies that are still likely to persist.

Pacific Northwest

Fire Behavior. Making observations on the rate of spread of small segments of fires as related to fuel type, topographic, and weather conditions received highest priority during this period. Eight fires were studied, adding considerable data to that already accumulated in previous years. General observations were also made on other phases of fire behavior and upon fire suppression activities. It was noted that the general behavior of several fires gave substantial foundation to the oft-repeated observation that the rapid spread of our larger fires is due principally to embers spotting ahead rather than to the running advance of a solid front of flame. Sometimes these spot fires start several miles in advance of the main fire and are very baffling to the suppression crews. Thus the fire

which this year reburned more than 150,000 acres of the 1933 Tillamook burn was observed to have made its most rapid advances by spotting ahead over a wide area.

Rate of fire line construction was also studied, especially as affected by size of crew. Assistance was given the Region in designing forms on which to make a record of the performance of the experimental 40-man suppression crew. This crew was used on a number of fires, and it is expected that the records of their output of held line as related to cover conditions will yield worth-while information.

Tests of fuel moisture indicator sticks, two in number, were run during the summer. One, using square, flat, and round sticks exposed in the shade and in the open, was designed to show the effect of shape, method of preparation, and method of exposure upon the daily moisture contents of the sticks; the other study was made to determine the effect of different kinds of ground surface conditions and height of exposure. Calibration tests were also made on the sticks used in the latter experiment.

Fire danger rating received the full attention of Wilkinson, who has been at the Station since 1936 working on this project under cooperative arrangements with the Regional Forester. He returns to the administrative office October 1 to work on fire control replanning. During the summer a complete check was made of the records kept at the fire danger stations on the national forests. A study was also made of the occurrence of fires on weekdays versus their occurence on weekends, Sundays, and holidays, as well as during the hunting season. Results of this study will be released soon. August fire danger station records from 1934 to the present were summarized and served as the basis for an interesting comparison of past seasons with the 1939 fire season. As reflected by the fuel moisture indicator sticks, August 1939 appears to have been drier in the Douglas fir region than any other August since the sticks came into use in 1934. The problem of the number and location of fire danger stations was attacked in several ways. Morris made a statistical analysis of records in order to determine how many stations are necessary in order to get reliable estimates of conditions on a ranger district, and he has submitted an article to the Journal of Forestry describing his results.

Analysis of a Sample Protection Unit. The Advisory Council at its September meeting recommended that the Station make an analysis of a sample protection unit of private land in order to determine the cost of adequate fire protection and the economic benefits which might justify adequate protection. Since this appears to be the logical approach to the basic problem of private fire protection and

private forestry in this region, it was decided to make such an analysis and plan for adequate protection. Snohomish County, Washington, has been selected as the sample unit. A tentative outline of procedure for the analysis phase has been drafted. A fuel type map and seen area maps will be made immediately in order to complete the field work before winter.

Southern

General

Tentative proposal for fire danger rating was made and submitted to Region 8 and the Appalachian Station. It consists of two meters, one for the herbaceous fuels of the longleaf-slash pine type, the other for the litter fuels of the shortleaf-loblolly-hardwoods type.

Effects

An informal study on the effects of burning on seedling development was completed. Longleaf pine seeds fell, in the fall of 1935, on the spot where the top of a felled snag had burned out a few weeks previously. These seedlings were measured in January 1939 to compare with seedlings that were less favored in their landing spot. This measurement showed that such a seedbed had, on the average, doubled their diameter at the ground in three years and that their height was approximately six times that of seedlings of the same age elsewhere.

In another study, analysis of data taken to measure the effect of fire on radial growth revealed, on the average, an apparent loss of growth of 20 percent during the growing season immediately after the fire.

FOREST GENETICS

California

Occurrence of Twins in Pines. The phenomenon of twin occurrence in pines has been observed at the Institute of Forest Genetics for a number of years. Special attention was given to the subject in 1938 and preliminary results are now available on the frequency and manner of occurrence of twins in Pinus ponderosa.

Interest in twin seedlings of Pinus revolves about the possibility of finding plants with an aberrant chromosome number. MÜntzing 1/ in reviewing the previous work on twin seedlings of several plant species cites the occurrence of twin plants having half normal, normal, one and one-half normal, and twice normal chromosome numbers in the vegetative tissues. In most cases where an abnormal chromosome number occurred the plant having the unusual number was smaller than its twin. Several pairs of twins produced in the seedbeds at the transect nurseries show a striking difference in size and it is hoped that some of these may be found to have an abnormal chromosome number. To the plant breeder this is important because many superior crop plants have been found to have a larger chromosome number than the wild ancestors of these plants.

Interest in twin seedlings arises also from the possibility that some of them may be the means of ultimately developing a pure line of pines, something that probably has never existed in nature, and something that, with such heterozygous material, could be secured by ordinary plant breeding methods only after an exceedingly long period of inbreeding. If a seedling with half the usual chromosome number is found among the twins, special heat or other treatments will be employed in an effort to double this haploid number. Should these treatments be successful, the normal chromosome number would be obtained without cross fertilization, and a pure line of pines should result.

In the test under consideration the seed from each of 29 seedtrees was kept separate, and the seed of each tree was graded with screens into from 5 to 8 size grades depending on the range in size of the seed from each tree. Observations in nursery beds during the period of germination disclosed 33 pairs of twins and one group of triplets. Twins of Pinus are relatively easy to detect since the seedling brings the seedcoat above ground as it comes up, and in the case of twins two sets of cotyledons emerge from a single seedcoat. Twin trees were marked with colored rings before the seedcoat was shed to insure positive identification at later stages of development.

This provided an excellent opportunity to study the relationship of seed size to the occurrence of twins in the 13 progenies where one or more pairs of twins appeared. This relationship is presented in the following table. For the purpose of summation, the "mode" of occurrence for the seed from each tree, or the size grade having the greatest number of seeds, is given the designation "0", those grades having smaller sized seeds are marked "-1", "-2", etc., while those grades having larger sized seeds are marked "+1", "+2", etc.

1/ MÜntzing, A. " Polyploidy from Twin Seedlings." Cytologia, Fugii Jubilee. Vol: 211-227. June 1937.

Relative grade	No. of pairs of twins produced	Percentage of sowed seed producing twins
-3 (Smallest seed)	0	0
-2	2	.07%
-1	4	.12%
0 (Mode)	6	.18%
+1	8	.24%
+2	8	.35%
+3	5	.51%
+4 (Largest seed)	1 (Triplet)	.23%

As fewer seeds of the extreme grades were available for sowing, the actual number of pairs of twins produced by each grade is not a true index of the frequency of their occurrence. The latter can be judged better from the column showing the percentage of the sowed seeds of each grade that produced twins. Aside from the first and last items, which are necessarily based on relatively small numbers, these percentages are quite reliable as each is based on the sowing of 900 to 3,000 seeds, with a grand total of 16,900 seeds for all eight grades.

If the last percentage is disregarded it is seen that there is a consistent tendency among the seeds from any one seed-tree for the proportion of twins to increase markedly as seed size increases. Thus, if a seed were selected at random from a +3 grade the chance that it would contain a double embryo and produce twin trees is about seven times as great as if the seed were taken from a -2 grade. Of interest also is the fact that the only triplet came from the largest of all of the relative grades. This knowledge, together with the information as to which seed trees yield the most twins, will prove very helpful in the future in our efforts to secure more of these interesting twins and triplets for experimentation.

Vegetative Propagation of Pines. Experiments during the summer with vegetative propagation of pines by grafting has produced some interesting results. It was found that seedlings of pines belonging to different groups can be easily grafted on Monterey pine, Canary Island pine, on Coulter pine and pinon pine and ponderosa pine. To date, grafting has been performed with eleven species of pines. The technique developed during these experiments is to be used in multiplication of pines, when propagation by cuttings is not feasible, and also in studies of physiological interrelation between scion and stock. A complete account of these experiments, together with a review of the literature, was prepared as a report entitled "Vegetative Propagation of Pines by Grafting." Experiments with vegetative propagation of pines by cuttings were continued and a small number of sugar pine cuttings was rooted.

Nutritional Studies with Pine Seedlings. Additional nutritional experiments with ponderosa pine seedlings were carried out and frequent chemical analysis both of plants and of nutrient solution were made in order to determine minimum requirements of ponderosa pine seedlings for certain elements. It is of interest to note that, in the absence of magnesium, otherwise harmless amounts of calcium become toxic to the seedlings. Results obtained in other regions with other species, indicating that phosphorus can be excluded from the nutrient medium during the early stage of development of seedlings, could not be applied to ponderosa pine. With this species, absence of phosphorus in nutrient solution manifested itself in the poorest development of the seedlings.

Northeastern

Birch seed set to controlled pollination was harvested during the last week in August. Although considerable quantities of seed have been obtained from hybridizations between birch species, the fact that this genus apparently produces parthenocarpic fruit and possibly also parthenogenetic seed makes it impossible to determine the extent of successful hybridization. It is still too early to determine the results of breeding work on other genera.

A short preliminary job on the occurrence of natural polyploidy in Acer rubrum was started and completed within the past two months. Stomata counts on herbarium specimens of leaves obtained from various parts of the United States (specimens from The New York Botanical Garden) indicate that the stomata number per unit leaf area varies considerably. However, the data do not give any highly significant evidence of the existence of polyploid geographic races.

A considerable number of seedlings derived from controlled pollination in the spring of 1938 have been brought through the seed-flat stages successfully and are now growing in pots at the Hopkins Memorial Experimental Forest. Most of the seedlings obtained from controlled breeding in 1937, which were carried through the winter of 1938-39 in the cold frames at the Hopkins Memorial Forest, have been transplanted to nursery rows. Although the weather has been quite dry during the past summer, these seedlings have shown excellent survival.

Allegheny

Stand Studies

Average diameter growth figures for the Worcester County, Maryland, loblolly pine sustained yield unit are as follows:

Diameter Growth of Merchantable Stems

	Mean Diameter Growth					
	5 Year Period			10 Year Period		
	Growth	Error		Growth	Error	
	Inches	Inches	Percent	Inches	Inches	Percent
Region A (NE)						
Pines 1/	0.87	±0.017	2.0	1.80	±0.036	2.0
Red oaks 2/	.87	± .017	2.0	1.47	± .096	6.5
White oak	.71	± .053	7.5	1.47	± .096	6.5
Misc. hardwoods 3/	.60	± .036	6.0	1.09	± .065	5.9
Region B (SW)						
Pines 1/ & Red oaks	.76	± .013	1.7	1.59	± .028	1.8
All other species	.56	± .022	3.9	1.05	± .043	4.1

1/ P. taeda, P. rigida serotina, P. rigida, P. echinata, and P. virginiana. (First two mainly).
2/ Q. rubra, Q. velutina, Q. borealis maxima, Q. palustris.
3/ Liquidambar styraciflua, Acer rubrum, Nyssa sylvatica, Quercus nigra, Quercus phellos.

Growth in the unit fell into the significant groups listed. Regional differences are probably due to a combination of soil and stand conditions. Region B has generally poorer soils and older stands. No differentiation of site, age, or condition was made in the field because application will be made on the basis of a 100 percent cruise disregarding these factors, in merchantable stands. Merchantable stands have 2,000 board feet and over (approximately 20 years and older), with merchantable pines 7" d.b.h. and over, hardwoods 9" d.b.h. and over. Diameter growth of merchantable trees did not vary significantly with diameter.

Appalachian

Volume Tables for Southern Appalachian Species. Volume tables for important Appalachian species previously presented in Technical Note 19 are being revised by a force of W.P.A. computers. Requests for local volume tables of many species are continually being received, and the revised tables based upon many additional data will include form class, as well as d.b.h. and merchantable length, as factors affecting volume. The measure of form being used is the ratio of the outside bark diameter at the top of the first 16-foot log to the outside bark diameter at breast height. This form class differs from that proposed by Girard because the outside diameter at the top of the first log instead of the inside diameter is used. It is believed that in cruising timber this outside diameter can be more accurately estimated by the average forester than can the inside diameter. Preliminary work has indicated that an equation of the form:

$$\text{Logarithm of volume} = b_1 (\text{logarithm of d.b.h.}) + b_2 (\text{logarithm of height}) + b_3 (\text{form class}) + c$$

will fit the data well.

The variation of form class with species and with localities is to be studied, to discover whether species can be combined and whether certain form classes are typical of various parts of the Station's territory.

California

Growth in selective stands. The 10-year periodic measurement of methods-of-cutting plots was undertaken by a three-man crew of student assistants who examined fourteen plots in a three-month period. Five of these plots on the Stanislaus are 30 years old and the crown canopy is beginning to close again to the detriment of competing brush. In the last 10 years some of the plots have had as many as 125 trees per acre growing into the 4-inch class. Most of these new trees are not reproduction, but advance growth that has been retarded for more than 30 years by brush competition. Most of these trees are white firs.

The series of methods-of-cutting plots established in 1939, to compare economic selection and standard Forest Service marking, also were remeasured. It has not been possible to summarize growth data, but losses have been tabulated below. The plots are in the sugar pine-white fir type, two in the Stanislaus and two in the Sierra National Forest.

Loss, bd. ft. per acre, annually, 1929-1939

	Stanislaus Plots	Sierra Plots
Forest Service marking	78	32
Economic selection marking	804	401

Growth in selection stands. The analysis of growth in selection stands has been completed to the stage of final adjustments and checking of the predicting alinement charts. Three final charts have been prepared:

1. Gross growth of stand 11.6 inches d.b.h. and over.
2. Gross growth of trees growing into the stand 11.6 inches d.b.h. and over.
3. Loss in the stand 11.6 inches d.b.h. and over.

Rough drafts have been written covering the analytical and historical phases of the proposed publications.

Growth of residual trees. A good start has been made on the study of the growth of trees which were released following cutting from 10 to 50 years past. During the summer a total of approximately 1,000 increment cores were taken from about 425 redwood trees. Concurrently the number of years since the release, together with tree and site description data were recorded. It was decided to confine the first year's field work to Humboldt County rather than try to cover the entire redwood region. Following the study of the material now available, a decision will be made as to future plans for this work. Considerable difficulty was experienced in finding the most desirable types of trees and situations for this study but it is believed that it will be possible to obtain results of value on the basis of the first year's work.

Redwood volume tables. Copies of the preliminary redwood volume tables which were prepared by Hallin were given to the cruisers of two of the largest redwood companies for checking against their other methods. Measurements were also taken on 250 additional trees from outlying areas for use in checking the accuracy of the tables for stands not represented in the initial sampling.

Port Orford Cedar. Region 5 has recently liberalized its policy in regard to the sale of Port Orford cedar stumpage and more accurate volume tables are necessary. At the request of Mr. Woodbury, Hallin has recently obtained measurements from 80 trees in the Pecwan Creek and Willow Creek areas of the Klamath and Trinity National Forests.

Central States

The first draft of the revised and condensed report of the growth and yield phase of the black walnut plantation study was completed on August 29. Initial work on the revision and condensation of a companion report on other phases of the study is under way.

Considerable progress was made on the growth and yield study of plantation black locust. All of the basic regressions have been prepared. Considerable difficulty was encountered in cross-checking these regressions probably due to the presence of the locust borer and the pronounced effect of sprouting.

Local Volume Tables. The Station has cooperated with the Ohio Woodland Survey in the preparation of some initial tables. The Survey provided stem measurements taken in Stark County, Ohio, by the climbing method. Average curves of volume over age have been prepared for (1) yellow poplar, (2) cucumber, (3) basswood, (4) red oak, (5) hard maple, and (6) black walnut. Another table for white oak is nearing completion. A curve of merchantable height over age for each species also has been prepared to permit county comparisons.

Lake States

Yield Tables for Northern White Cedar. Northern white cedar is one of the few timber species of the Lake States for which sufficient volume and yield information has not been available in the past. In order to make up this deficiency of information, several volume and yield tables are now being compiled from the results of a number of studies made over a period of years by the Station.

It has been thought best to present only a few volume tables, but to include all the necessary basic tables from which others may be prepared according to individual need. A taper table has been prepared, showing the most probable values of diameter inside bark at regular intervals of distance above ground, for trees of different d.b.h.'s and total heights. These data on average taper were then used to construct tables for any product and utilization standard required.

The yield tables will be based upon 135 fifth-acre sample plots taken in stands of northern white cedar in the three Lake States. The stands sampled were well stocked and essentially even aged. The plots obtained were found to represent very largely the medium range of sites--centering around index 51 (at 160 years), the average of the sample. The great body of commercial cedar stands in the Lake States falls within the medium range of sites (indexes 45 and 55).

A table giving the percentage distribution of trees by d.b.h. classes in normal stands was prepared first. This distribution served as the basis for preparing all stand tables used in the construction of the yield tables. Tables have been prepared that show normal yield in cubic feet, board feet, and in common cedar products, such as poles, posts, and ties.

Pacific Northwest

Revision of Growth Study Procedures in Selectively Cut Pine. Reanalysis of Dr. Meyer's basic data of board-foot growth in selectively cut ponderosa pine stands concluded this summer has resulted in a revised and improved technique of estimating the increment of such stands. The independent variables used in the estimation are tree class, tree size, site index, and total volume of the reserve stand. Dr. Meyer's data were recorded in Dunning tree classes, and since this region has subsequently adopted the Keen tree classification there remains the problem of adapting the new technique for use with the Keen tree class system. Progress has been made toward improving the accuracy of estimating the increment resulting from the passing of poles into the merchantable size class and their subsequent growth. Probably several months of additional work will be required to complete this technique. Methods of estimating mortality in ponderosa pine reserve stands in this region are still far from satisfactory and much additional data based on experience and more analytical work will be required to provide an adequate procedure.

Permanent Growth Study Plots in Fir. During September, 5-year periodic remeasurements were made on 7 growth study permanent sample plots in even-aged Douglas fir in the Wind River Valley; 3 were remeasured on the Mt. Hood Forest. An innovation in growth plot examination has been tried this year, namely, recording information on the status of natural pruning in order to have some measure of quality growth as well as of volume growth. For 40 or more trees on each plot information on the following points is taken--length of clear bole, length to beginning of live crowns, length to point where limbs have broken off naturally, average length of stubs of broken branches, and percentage of flush breaks. This technique has been used with apparent success on five stands of ages 29, 37, 54, 84, and 99.

Rocky Mountain

Stand studies.

Computation and analysis of the growth and yield data for partially cut stands of lodgepole pine has recently been completed. The analysis was made by performing a multiple correlation in which

gross yield was the dependent variable, and reserve volume, years since cutting and site index the independent variables. Benefiting from previous experience in ponderosa pine, all data were coded in logarithms before the analysis was started. This procedure resulted, as in the case of ponderosa pine, in a linear relationship between dependent and independent variables. The simple correlation coefficient between gross yield and site index was not, however, significant, nor did the inclusion of site index as a third independent variable significantly improve the multiple correlation coefficient.

The failure of site index to reduce variation in yield was attributed to the field technique in determining site quality for partially cut stands. Apparently further refinement in site determination must be developed before the influence of site quality can be properly weighed.

The multiple correlation coefficient between the dependent and the first two independent variables in terms of logarithms was 0.9482 and its corresponding coefficient of determination is 0.8991.

The calculated regression equation was:

$$X_1 = 0.7042\ X_2 + 0.4512\ X_3 + 0.6961$$

Where:

X_1 = log. gross yield.
X_2 = log. reserve volume.
X_3 = log. number of years since cutting.

An alinement chart based on the above equation and then transposed to natural numbers disclosed an aggregate error of only 0.15 percent and an average percentage deviation of 16.4 percent. A table of gross yields as read from the chart is given below:

Yield of Partially Cut Stands of Lodgepole Pine

Reserve volume	Number of years since cutting				
	15	25	35	45	55
Board feet	Gross yield per acre in board feet				
1,000	2,290	2,870	3,320	3,720	4,040
2,000	3,670	4,600	5,360	6,000	6,550
3,000	4,860	6,120	7,100	7,900	8,610
4,000	5,950	7,450	8,650	9,600	10,500
5,000	6,950	8,650	10,000	11,200	12,200
6,000	7,800	9,800	11,300	12,700	13,900
7,000	8,600	10,800	12,500	14,000	15,300

Reliable mortality data were available for only 16 permanent plots. The average annual mortality per acre was found to be about

22 board feet. Additional mortality data are obviously needed, and to obtain this, 5 mortality plots 1 x 80 chains in size have been established in recently cut stands. Additional mortality strips are contemplated as time and opportunity permit.

Southern

Test of volume table procedure. Girard suggested some time ago that a merchantable cubic foot volume table for second-growth southern pines might be made by a simple generalization of the volume table procedure presented by him in the Journal of Forestry.1/ The new procedure is as follows:

1. Compute the form point of each tree. (Form point is defined as the ratio of the diameter bark in the middle of the merchantable part of the tree to the D.B.H. outside bark.)

2. Plot form point over D.B.H. and curve.

3. From the curved values of form point the estimated mid-diameter of the tree can be calculated, i.e., Mid-diameter = Form point x D.B.H.

4. The cubic volume of the tree then is the product of the basal area (in square feet) of the mid-diameter and the merchantable length (in feet).

This procedure assumes that the form of the tree is that of a paraboloid and that form point is independent of merchantable length. To test the last assumption and also the general applicability of this procedure of constructing volume tables, use was made of some volume table measurements taken on 108 loblolly and 97 shortleaf pine trees cut on the San Jacinto Experimental Forest. These trees were subjected to a convariance analysis which is shown in tables 1 and 2. From these tables the correlations of form point with merchantable length (number of bolts) within a diameter class was found to be -.38 for loblolly pine and -.31 for shortleaf pine. Both of these coefficients are significant, indicating that form point is not independent of merchantable length. The regression coefficient of form point on merchantable length within diameter classes was found to be -.0121 for loblolly pine and -.0113 for shortleaf pine. Thus for an increase in merchantable length of 1 bolt (4') form point decreased about .05. For small trees this discrepancy in form point would make only a small change in the basal area of the mid-diameter, the percentage error being approximately twice the percentage error in diameter.

To make a complete check on Girard's procedure for constructing volume tables, the actual tree volumes were compared with a volume table made using the average form point of each diameter class. The discrepancies by diameter classes are shown in table 3. When the curved form points were used the discrepancies were about the same.

1/ Volume tables for Mississippi bottomland hardwoods and southern pine. Journal of Forestry 31 (1): 34-41. 1933.)

Using the method described above it is an easy task to construct a volume table which should be fairly satisfactory if a high degree of accuracy is not necessary. If the trees used to construct the volume table represent a random sample of the stand being cruised, then the table made from these trees may be more accurate than a table made from trees not taken on the particular tract of timber concerned.

Table 1.

Loblolly Pine O. B.

Source of variation	Degrees of freedom	Sum of the square		Cross products	Mean sum of the sq. of form point	F
		Form point	No. of bolts			
Between D.B.H. classes	10	.2014	596.1393	-9.6753	.02014	15.36 VS
Within classes	97	.1273	125.5274	-1.5158	.00131	
Total	107	.3287	721.6667	-11.1911		

Table 2.

Shortleaf Pine O.B.

Source of variation	Degrees of freedom	Sum of the square		Cross products	Mean sq. of form point	F
		Form point	No. of bolts			
Between D.B.H. classes	8	.1108	377.7713	-5.2529	.01385	9.41 VS
Within D.B.H. classes	88	.1298	95.7132	-1.0814	.001476	
Total	96	.2406	473.4845	-6.3343		

Table 3.

Difference between actual and estimated volume as a percentage of the estimated volume, calculated by species and D.B.H. groups

	D.B.H. class - Inches											
	5	6	7	8	9	10	11	12	13	14	15	Total
	Percentage discrepancy											
Actual average form point												
Loblolly	12.3	.9	6.5	6.4	3.0	1.8	.6	4.7	8.4	3.0	-.6	3.7
Shortleaf	3.5	5.4	9.0	4.7	2.0	3.3	-1.5	-1.1	-.2	6.0	.1	3.0
Curve form point												
Loblolly	5.8	8.1	6.5	3.8	.4	6.7	-1.9	1.7	8.0	3.0	-.6	3.3
Shortleaf	8.3	.1	9.0	4.7	2.0	6.2	-6.8	-1.1	7.3	6.0	-6.9	3.8

REGENERATION

Appalachian

Direct Seeding. Records of germination, survival, and site factors for the first growing season for the seed spot experiment are practically completed. This study included tests of three species of pine, spring sown and fall sown, spots screened and unscreened, with several ground treatments, and two site conditions at each of two locations in the Piedmont region.

Although the data are not yet analyzed, preliminary summaries for the Enoree unit in South Carolina show definitely (1) that fall seeding is superior to spring (early May) seeding, (2) that except for the first month, during which there may be some heat injury, drought is by far the most important cause of seedling mortality, (3) that shade effect, as well as biotic protection of screens, is an important factor in seedling survival, and (4) that ground treatments have markedly different effects on different sites. On an eroded site with clay soil and sparse plant cover, mulching the spots with pine litter was highly beneficial, but scarification with a mattock to a depth of about 5 inches did not appreciably effect germination or survival. On a comparatively uneroded site with about 6 inches of loamy sand topsoil covered by an open stand of broom sedge, mulching seemed actually to be detrimental, but scarification of spots and covering the seeds by raking was highly beneficial. The benefits of scarification on the vegetated site probably were attributable

to the removal of competition, but the unfavorable reaction to mulching is still unexplained.

The following table gives a summary of germination and survival for the fall-sown plots, as of September 23, for all species (loblolly, shortleaf, and Virginia pines) combined. The number of seeds germinating and the number of survivors per spot is of a possible 25. Percentages of successful spots (those having at least one live seedling) are based on a total of 36 spots under each treatment. Percentages of germination are based on totals of 900 viable seeds sown. The consistently higher germination under screens is interpreted as a result of protection against birds and rodents; the consistently higher percentages of survival under screens is interpreted as a measure of the effect of shading.

Figures for the spring sowing (not here included) are decidedly lower for all treatments. No summaries have been prepared as yet for the Lee unit in Virginia. It is expected that figures for this unit will run consistently higher than for the Enoree because this year's rainfall on the Lee was much heavier and more frequent.

Germination and survival for all species on the Enoree unit - fall sown

Spot treatments	Scarified, raked, and mulched		Scarified and raked		Scarified and mulched		Scarified		Raked and mulched		Raked		Mulched		No ground treatment	
	Scr.	Un-scr.	Scr.	Un-scr.	Scr.	Un-scr.	Scr.	Un-scr.	Scr.	Un-scr.	Scr.	Un-scr.	Scr.	Un-scr.	Scr.	Un-scr.
	Eroded site - clay soil, sparse vegetation															
Avg. no. germinating per spot	6.1	5.3	3.2	0.7	10.9	7.0	1.2	0.0	7.5	4.7	4.7	0.8	11.2	6.6	0.5	0.1
Avg. percent germination	24.3	21.1	12.9	2.7	43.4	28.1	4.9	0.0	29.9	18.7	18.8	3.2	44.7	25.4	2.1	0.6
Avg. No. survivors per spot	4.8	2.8	2.6	0.5	8.3	4.4	0.8	0.0	5.4	1.9	4.1	0.4	8.8	4.0	0.5	0.1
Avg. percent survivors of germination	78.1	53.7	81.9	70.8	76.0	62.8	65.9	0.0	72.1	39.9	86.4	55.2	78.9	60.5	89.5	80.0
Percent successful spots	83.3	75.0	77.8	38.9	88.9	72.2	36.1	0.0	86.1	58.3	91.7	33.3	91.7	83.3	22.2	5.6
	Comparatively uneroded site, sandy soil, broom sedge cover															
Avg. no. germinating per spot	4.4	4.4	7.1	2.4	6.4	5.2	6.0	0.2	2.5	1.8	8.3	1.9	2.5	1.5	11.6	0.7
Avg. percent germination	17.4	17.6	28.3	9.8	25.7	20.7	24.0	0.8	10.1	7.3	33.2	7.8	9.9	6.1	46.3	2.7
Avg. no. survivors per spot	2.5	1.3	5.0	1.0	2.6	1.3	4.1	0.1	0.2	0.2	1.9	0.2	0.1	0.0	1.8	0.0
Avg. percent survivors of germination	58.0	28.5	70.6	40.9	39.8	24.7	67.6	37.5	6.6	10.6	23.1	8.6	3.4	0.0	15.1	0.0
Percent successful spots	58.3	50.0	100.0	58.3	55.6	50.0	72.2	5.6	13.9	11.1	58.3	13.9	8.3	0.0	47.2	0.0

Species Adaptation. The spot germination count on 186 oak and walnut direct seeding plots planted in January and February 1939 was made in June and early July. These plots are part of the second half of the series of experiments being carried out in cooperation with the Tennessee Valley Authority in the Great Appalachian Valley. The oak germination was much poorer than on the plots planted in 1938, 54 plots having failed as against 14 in 1938. Walnut germination was good, no plot failures being reported out of 66 plots. About 55 percent of the spots had one or more seedlings in early summer. At the spacing used, this is 663 trees per acre, and further walnut germination usually continues throughout the summer and the second spring.

Most of the oak plot failures this year can be definitely attributed to poor acorns. Local rodent damage was present to about the same extent as in 1938 and did not account for more than 10 percent of the unsuccessful oak plots. No germination occurred from southern red oak acorns and most of the bur oak also failed. White oak, as last year, showed a low germination. The acorns of this species must either be hand picked for healthy sprouted seed or at least 4 acorns planted per seed spot. Except for several batches of defective seed, northern red oak, black oak, and chestnut oak gave good germination.

The examination for height and first-year survival of the Tennessee plots planted in the winter of 1939 was started in mid-September. The 1939 growing season was considerably drier than normal as contrasted with an exceptionally favorable year in 1938. In 1939, May had about 25 percent normal precipitation and practically no rain fell in August and September. This late summer drought has caused premature leaf fall on most of the species. The examination has not yet been completed but in spite of the dry season it is now apparent that first-year survival will be good for all 14 species, although it is not as high as that for 1938.

Spruce Type Study. The working plan for the spruce type regeneration studies has been completed and plots located in the different vegetation types. On the Monongahela National Forest 262 plots on 6 cover types have been located and on the Pisgah National Forest 102 plots on 3 vegetation types. Planting will be done in the spring of 1940.

California

Brushfield planting. The Burney Spring plantation has now passed the third growing season. The principal comparison being made is survival of ponderosa and Jeffrey pine under three methods of brush eradication; burning, stripping with trailbuilders, and

burning followed by stripping. Survival remains high for all three treatments. The principal differences are attributable to selective rabbit damage. The combined burning and stripping treatment maintained its advantage in percentage of surviving normally developed trees for the third year by providing more effective brush control and inhibiting reinvasion by rabbits. Although 1939 would be classed as an exceedingly poor year on the basis of preciciptation deficiencies, survival in plantations has been good. Soil samples taken the first of June revealed more favorable moisture conditions than in 1938, and as late as September 20 the moisture content was still two to four per cent above the wilting percentage.

Season of planting and methods of stock storage. The Feather River plantation, designed to compare fall and spring planting and four methods of storage of ponderosa and Jeffrey pine stock, showed first season survival of about 90 per cent, despite the extremely low rainfall. Stock stored from December to April in a refrigerator at 38° F. suffered losses from 10 to 15 per cent greater than stock planted without storage or after storage in a heel-in-bed. Contrary to previous experience, the smallest grade of stock showed survivals within about 5 per cent of the larger grades. As in previous plantings, the period of greatest mortality did not coincide with the period of lowest soil moisture, although the moisture percentage fell to about 10 in mid-September.

Grades of seed and stock. Germination in the Feather River ponderosa and Jeffrey pine seed beds was generally satisfactory. The largest seed showed significantly poorer germination than the smaller grades. Seedlings from the largest seed grade were the largest, however, and previous tests have indicated that superior seedling size is reflected in better 1-1 transplants and higher field survival. After thinning to equalize spacing, enough trees of all grades survived to provide material for the transplant and field planting phases of the study.

Central States

A nursery soil fertilizing experiment was set up for the purpose of testing: (1) Response of pine seedlings to varying amounts of superphosphate; (2) Effects of ammonium sulfate and potassium sulfate applied in solution, two, four and six weeks after seedling emergence; (3) The possibilities of using raw rock phosphate and greensand marl as sources of phosphorus and potassium, respectively, with and without acidulation after application. The seedlings will be measured in the spring for survival, root and top lengths, and both green and dry root and top weights.

Intermountain

Methods of Planting: On most forest planting jobs in the central Idaho region the ordinary mattock or grub-axe is the tool commonly employed. It is a good all-round implement and probably has no peer on brushy sites or in rocky terrain. Nevertheless, it appears sound strategy to try out other types of tools to ascertain whether any good bets are possibly being overlooked and to determine what sort of advantages various tools possess when the results are measured not only in terms of initial time expenditure but also in terms of survival and growth of the planted seedlings. Accordingly, an experiment designed to test several types of tools or methods of planting was initiated at the Boise Basin Branch Station in the spring of 1938 and repeated in the spring of 1939. The tools used in the 1939 test were:

1. Mattock -- employed to grub out broad groove 10 to 12 inches deep.

2. Baby shovel -- employed to dig out deep hole 16 to 18 inches in depth.

3. Baby shovel -- employed to dig out shallow hole 8 to 10 inches in depth.

4. Baby shovel -- employed to make narrow slit by vertical thrust, bar fashion, 8 to 10 inches deep.

5. Council planting bar with adjustable step -- employed in the usual manner, i.e., regular bar technique; depth of slit 12 to 14 inches.

6. Council offset bar -- employed in usual fashion; slit 8 to 10 inches deep.

7. Region 1 planting mattock -- employed to make narrow V-slit by thrusting or pressing blade into earth. (High gravel content prevented utilizing this tool in the intended fashion.)

As yet only the initial efficiency or net planting time figures are available from these tests. The net figures include only the actual time used up in planting given rows or blocks; idle time, travel time between plots, etc., are excluded. Ordinarily, this net time should serve as the best measure of relative

tool efficiency. Table 1 below gives the net planting time by type of tool or method of planting for the 1939 test:

Table 1.- Relative efficiency of various tools or methods of planting. Boise Basin, Idaho, planting test; May, 1939.

Type of tool or method of planting	No. of seedlings planted	Total net planting time (man-hours)	Net planting time per 1000 seedlings (man-hours)
Baby shovel - deep hole	750	26.1	34.8
Baby shovel - shallow hole	"	19.5	26.0
Mattock	"	16.2	21.6
Council bar - adjustable step	"	11.8	15.7
Region 1 planting mattock	"	11.0	14.7
Council bar - offset	"	10.5	14.0
Baby shovel - slit	"	8.5	11.3
All tools	5,250	103.0	19.6

In the above test 2-man crews, consisting of a tool-man and a stockman, were used throughout, on all tools or methods of planting. It is appreciated that different or more efficient crew organization may have altered the absolute time values materially, but probably would not have resulted in important changes in relative position of the various tools in this initial efficiency rating. The shovel-slit method is much the fastest; the shovel-deep hole much the slowest. As might be expected, the bars and the methods employing bar technique are definitely faster than the mattock or the tools employing digging or grubbing technique. Judgment of net advantages naturally must be postponed until data on survival and growth are available.

The quality of planting based on inspection at time of planting appeared satisfactory in every case except in that of the R-1 planting mattock. The high gravel content of the granitic soils prevented use of this tool in the fashion which its creators had intended and employed in any other way, it becomes an awkward implement.

Since other tests in this locality already have shown that methods causing a maximum of soil disturbance are definitely beneficial, at least so far as survival is concerned, it might be questioned why bar technique is now being brought up for consideration. The reason is this: Evidence points strongly toward competition of brush, grass, and weeds as one of the really important factors in both survival and growth. The chief advantage of methods resulting in maximum soil disturbance may well lie as much or more in reduction of plant competition than in breaking up soil compaction and in mixing of soil layers. If this premise is correct, then on fresh burns, contour furrows, or any other sites where plant competition is already at a minimum, use of bar technique might produce satisfactory results with a very material saving in planting costs.

Lake States

Nursery

Results of the intensive fertility tests carried on by Stoeckeler at the Hayward and Rhinelander nurseries in Wisconsin have brought out the fact that there is a great deal more difference in the quality of the stock produced by the two nurseries than between treatments (degree of fertilization).

The Rhinelander nursery, because of the relatively good quality of the soil, produces tall, top-heavy jack pine stock which suffers extremely heavy losses when transplanted in the field in the fall, whereas the relatively small Hayward stock survived well in the field. Spring planting of the same stock showed little difference between nurseries in field survival.

To obtain good survival, 2-0 Rhinelander jack pine must be field planted in the spring. If fall planting is necessary, the stock should be kept in balance by top pruning, the value of which needs further testing, or by producing $1\frac{1}{2}$-0 stock by sowing the seed in late spring (June).

Rocky Mountain

A grading experiment was started in 1938 on the Pike National Forest in Colorado to test the effect of size of planting stock on survival. Regular planting stock from the Monument Nursery was divided into three size classes; large, medium, and small, mainly according to thickness of stem at ground line. Since much planting in this region is done under aspen stands, one phase of this study was to determine the losses caused by the smothering

effect of aspen litter. All trees completely or almost completely covered by leaves during the winter 1938-1939 were recorded during an examination in early spring 1939. Most of the covered trees were still thrifty at that time. In a follow-up examination in September 1939, 88 percent of the trees completely covered and 65 percent of the trees almost covered were found to have rotted or dried up during the summer. The percentage of trees covered for the three size-c classes of Engelmann spruce 3-1 and lodgepole pine 2-1 stock were: large, 5 percent; medium, 12 percent; and small, 32 percent. Only five trees of the Douglas fir 3-0 plots under aspen were covered since this stock is at an average considerably taller than the planting stock of the other two species.

A summary of the losses for Engelmann spruce and lodgepole pine plots planted under aspen is presented in the following table. This table shows that the comparatively low survival in the small size classes is mainly due to the smothering effect of aspen leaves. The relatively low losses during extremely dry summer season of 1939 are rather surprising. These survival figures are based on thrifty trees only.

Comparison of losses due to smothering by aspen leaves with other causes

Size-class	Engelmann spruce 3-1			Lodgepole pine 2-2		
	Large	Medium	Small	Large	Medium	Small
% losses during summer 1938	28	21	27	4	11	21
% of trees living in fall 1938 covered by aspen leaves	1	9	31	8	15	33
% losses owing to smothering	1	6	23	5	10	21
% losses owing to other causes during winter '38/39 and summer '39	11	8	6	9	12	6
% survival, fall 1939	62	65	44	82	66	42

Southern

Seed studies

Seven-year storage of pine seed. A progress report on the Station's oldest current study of seed storage was completed. Germination tests at the end of seven years storage of longleaf, slash, loblolly, and shortleaf pine seed from the 1931 crop showed no loss

of viability when storage was at low temperatures (approximately 38° F.) in small closed containers. The moisture content of the seed on removal from storage was approximately 9 percent. Corresponding samples stored at room temperatures had become almost or completely non-viable in four years or less. Cold, moist stratification increased rapidity of germination in the loblolly and shortleaf seed lots held for seven years at low temperatures, but scarcely affected the slash seed, and was definitely harmful to the lot of longleaf seed in this study. The germination percentages of the cold-storage lots, on the thirtieth day, were as follows:

Species	Untreated	Stratified
Longleaf	67.2	50.8
Slash	74.8	89.6
Loblolly	0.4	82.0
Shortleaf	18.0	90.0

Effect of light upon germination of pine seed. Reports were also prepared completing two minor studies of the effect of light upon the germination of seed of longleaf, slash, loblolly, and shortleaf pines. These studies showed that light or some factor intimately associated with it may increase the amount, and more strikingly the rapidity, or germination of any lot of seed, and apparently of stored seed in particular. Yet lots that are exceptions to this rule occur frequently enough to indicate considerable differences in the light-requirements of different seed lots, arising from some cause as yet undiscovered. These results have a direct bearing upon the selection of environment in which to conduct germination tests, and also upon nursery practice, particularly depth and opacity of covering over seed in the beds.

Nursery

Thinning over-dense portions of stands in nursery seedbeds. During 1938 a study was made at the Stuart Nursery to determine the effectiveness of hand thinning in improving the growth and development of longleaf pine nursery stock. The stock was growing in machine-sown drills, with characteristic over-dense portions as a result of irregular flow of seed through the tubes of the machine. The treatments involved three degrees of thinning (to maxima of 10, 15, and 20 per running foot in drills 6 inches apart), and one unthinned check. An analysis recently completed shows that thinning produced higher plantable percentages with fewer culls per unit of area, and better quality of stock as expressed in terms of weight, but fewer plantable trees. Each decrease in density produced a significant decrease in number of plantable trees but a significant increase in plantable percentage and green weight.

Thinning as such is not an unduly expensive operation, but, because of relatively high initial seed costs, the loss in numbers through removal of seedlings substantially increases the cost of the remaining "crop" trees in the seedbed. Since lower densities apparently produce the best but most expensive trees, any contemplated change in density, obtained either by thinning or by rate of sowing, presents a problem that is essentially one of weighing cost against quality of stock produced.

Southwestern

Woodland Species. A preliminary study was started in June at Walnut Canyon to determine roughly by what means pinon and juniper seed could be induced to germinate and survive in the open. The following four treatments were applied to screened seed spots containing 20 sound seeds each of pinon pine, one-seed juniper (Juniperus monosperma), alligator juniper (Juniperus pachyphloea), and Utah juniper (Juniperus utahensis):

1. Artificial watering (twice a week during summer dry season, 2 inch surface water at each application).

2. Artificial shade (50 percent shade furnished by lath frames).

3. Combination, water and shade together.

4. Check, no treatment.

The four treatments were replicated four times.

The seed was planted June 8, and germination in the watered spots began July 1. In the unwatered spots, germination was delayed until August 15, about 2 weeks after the first effective summer rains. The seed of pinon pine continued to germinate for a period of about 10 days, while those of one-seed juniper required from 4 to 5 weeks to complete germination. None of the seeds of Utah juniper and only three seeds of alligator juniper have germinated to date. Evidently of the three species of juniper tested, only one-seed juniper germinates readily the first year without pre-treatment. The period of germination in the unwatered spots concurred with the germination of the few natural seedlings of pinon found under adjacent trees, indicating that pinon seeds, like those of ponderosa pine in the adjoining saw timber stands, usually germinate following the first heavy summer rains.

Total germination for pinon pine and one-seed juniper are given in the following table:

Species	Check		Shade		Water		Water & Shade	
	No.	%	No.	%	No.	%	No.	%
P. edulis	59	74	70	88	64	80	74	92
J. monosperma	9	11	35	41	31	39	56	70

For both species, the best germination occurred where the seed spots were both watered and shaded and the poorest germination in the untreated spots. The germination in the shaded spots was slightly better than in the watered spots. Whether or not the shading favored germination directly, or through its effect on soil moisture was not determined. The effect of watering and shading together on germination is much more pronounced with the one-seed juniper than with the pinon pine. For the juniper, germination was increased 59 percent as compared with the check, while the difference was only 18 percent for the pinon.

Although a few of the seedlings have already died, no very definite conclusions on survival can be drawn until the end of the second growing season. The seedlings under the shades seem to be making better growth and are in a thriftier condition, however, than those unshaded. Aside from the differences between the four treatments, the check treatment demonstrates that natural conditions in the openings in woodland stands are favorable for the germination and initial survival of pinon and juniper and indicates that the present understocked condition of such small areas is mainly due to absence of viable seed.

SILVICULTURE

Appalachian

Cut-over Area Analysis. The report on southern Appalachian cut-over areas, finished in first draft last spring, is being revised for publication. It embodies an analysis of data from 231 sample plots representing 17 cut-over areas, mostly on national forests in Virginia and North Carolina, which were only once cut

over, at least within recent years, and which were unburned since cutting. Its purpose is to describe and compare the prevailing conditions on heavily, moderately, and lightly cut-over areas, in different forest types, after different periods since cutting, and to provide a rough basis for appraising the qualities of cut-over areas.

The plot data were compiled to show, for the species classes "desirable" and "less desirable", the number per acre of (a) "poles" (4 in.-8 in.) and "timber trees" (9 in. and over, d.b.h.); (b) good and poor trees in each of these size classes; and (c) reproduction (total, shade-free, seedling, and sprout). These data were averaged in different combinations, by straight-line regression, to express average relationships between different stand categories, both with and without regard to severity and age of cut.

The influences of composition, age of cut, and severity of cut were studied separately. So far as could be judged, the species composition was very slightly altered by cutting; in fact, in many cases the percentage of desirable seedlings was even greater than the percentage of desirable trees. The greatest and most wide-spread change in composition was caused by the death of chestnut from the blight. Chestnut is noticeably diminishing in importance as a competitor with other species in the reproduction. In only six cases does it form as much as one-third of the reproduction, and in 25 cases less than one-fifth.

Definite relations were shown to exist between the numbers of trees and reproduction and the severity and age of cut; but when sub-classes were compared with totals, e.g., poles with total trees, desirable free seedlings with total reproduction, etc., tendencies, while noticeable, were not marked nor were the magnitudes of the variations large. This made it seem practicable to use averaged relations of the latter type, based upon the entire number of sample plots regardless of type, age of cut, or severity of cut, as standards from which to judge the qualities of any cut-over area.

The relations between total number of trees per acre and different classes of stand and reproduction are shown below. These averages, obtained by regression, are based upon the entire number of sample plots. Figures in boxes are the arithmetical averages for all cut-over areas examined.

Total trees	Trees				Reproduction			
	Poles		Timber trees		Total		Desirable seedlings	
	Good*	Poor*	Good	Poor	Free	Shaded	Free	Shaded
	Number per acre							
50	18	-	17	15	475	270	136	153
100	31	35	18	16	426	422	132	150
150	42	73	19	16	377	574	128	147
161	45	80	19	17	367	607	127	147
200	54	109	20	17	329	726	124	144
250	65	147	21	17	280	878	121	141
300	77	183	22	18	231	1029	117	138
350	88	221	22	19	182	1181	113	136

*"Good" and "poor" in the above table relate to condition of the trees, not to species.

Partial Cutting. Cursory observations made during periodic remeasurements of permanent sample areas in partially cut stands in the mountain hardwood types show an increase in the development of epicormic branches following the release of reserved trees. Apparently it will be necessary to include observations of epicormic branches as an integral part of the routine measurements of present and future methods of cutting studies.

The problem of epicormic branching may become a significant factor in the production of high-quality second-growth hardwoods in the southern Appalachians. In conjunction with the reexaminations of partially cut sample areas, it is anticipated that sufficient data will be collected to determine the conditions which favor the development of epicormic branches, the extent to which they develop, and the economic significance of their presence.

The table presents a preliminary analysis of the data collected in a partially cut stand of hardwoods. The 6-acre sample area was cut 5 years ago, reserving 24 percent of the original merchantable volume. The diameters of the reserved trees ranged from 10 to 19 inches. It is evident that there has been a considerable reduction in the clear stem length of many reserved

trees, caused by the development of epicormic branches below the base of crown. Many of these new branches are now more than 2 inches in diameter and often 10 feet long. In a number of trees the epicormic branches have definitely become part of the effective tree crown.

Reduction in the clear stem length of reserved trees during the 5-year period following partial cutting 1/

Species	Total number trees examined	Reduction in the clear length of trees by 16-foot logs						Trees with reduced clear length
		No reduction		Less than 1 log length		Between 1 and 2 log lengths		
		No. trees	Percent	No. trees	Percent	No. trees	Percent	Percent
Yellow poplar	33	11	33.3	11	33.3	11	33.3	66.6
No. red oak	29	12	41.4	13	44.8	4	13.8	58.6
Cucumber	7	1	14.3	3	42.8	3	42.8	85.6
White oak	7	0	0.0	4	57.2	3	42.8	100.0
Shag. hickory	4	1	25.0	2	50.0	1	25.0	75.0
White ash	4	3	75.0	0	0.0	1	25.0	25.0
Beech	4	4	100.0	0	0.0	0	0.0	0.0

1/ Clear stem length is defined as the lowest limb, living or dead.

California

Sustained yield at Blacks Mountain. Logging on the Blacks Mountain Experimental Forest got under way on May 16, when CCC felling crews started work. By the end of May all logging equipment had been put into good condition and yarding and truck hauling started.

During the early part of the season, Logging Superintendent Carlton and Foreman Fesler put the enrollees through a careful and thorough training on the job. Very few of the enrollees had had previous experience in sawing, chopping, or operating equipment, but they took readily to the work. The prospects for a good season were bright until mid-July, after which the logging was interrupted frequently when the crews were called off on fires. As the fire situation is

still critical, it is difficult to plan or hazard a guess as to the total output for the season. To date about 2,000 M feet B.M. have been delivered to the Fruit Growers mill. The goal set for the season was 2,500 M feet.

By August, 371 acres had been cut over by the sanitation-salvage marking, by which about 3 M feet gross per acre is removed in trees of poor risk from the insect standpoint. The four compartments cut under this system were selected on the basis of risk surveys run last season by cooperating entomologists.

This year's block (Block 39) of methods-of-cutting plots was prepared for logging, and since August 5 cutting has been confined to the plots. The total volume marked on the 180 acres in this study area is 1,400 M feet B.M. All trees 11.6 inches d.b.h. and over have been mapped, measured, described, and log graded. Trees from 3.6 inches to 11.5 inches diameter, inclusive, were tallied by diameter class and tree class within 1 by 1-chain units. The estimate of area in reproduction or shrubs was obtained by a line sampling procedure. The cutting treatments include: clear cutting, which takes all merchantable trees; heavy Forest Service marking, which removes 75 to 85 percent of the volume; modified Forest Service marking, which removes 50 to 65 percent of the volume; silvicultural selection, under which a sanitation-salvage cut is followed at varying intervals by cuts of varying intensity; entomological cut, by which only trees of poor insect risk are removed; and a control plot. Each treatment covers 30 acres, including 10 acres in isolation strip. The two Forest Service systems of marking were applied by Kevin and Wagner of the Regional Office. Each plot is marked under all systems, and cutting treatments are assigned by random selection.

The six plots for Block 40 have been selected, and are being surveyed, subdivided, and mapped while logging progresses in Block 39. As logging and brush disposal are completed, the reexaminations of Block 39 are being made. By the close of the season two blocks will have been established. It is planned to establish eight more of these blocks, one each season for the next eight years.

Two tests of Davey pneumatic saws were made during the season, and a demonstration was put on by representatives of the Davey Company at Blacks Mountain in June. Representatives of several nearby lumber companies witnessed the demonstration. The saws in present stages of development did not prove satisfactory under our conditions where a light cut necessitates frequent moves of equipment.

Redwood Experimental Forest. The Forest Service has finally acquired a small area of virgin redwood, 6,240 acres, in the northern redwood purchase unit. The initial purchase includes part of an area of 3,000 acres proposed in 1935 for a northern redwood experimental forest. Now that the possibility of acquiring a forest seems less remote, Person and Hallin spent some time in the examination of the initial purchase unit and adjacent areas including High Prairie Creek. This examination confirmed our preliminary survey of 1935 and a request is being made for the establishment of an experimental forest area of about 3,000 acres in the High Prairie Creek drainage. It was decided that the initial purchase would not be suitable for a northern redwood experimental forest because the stands are not comparable in volume to those now being logged by operators in Humboldt and Del Norte Counties.

Central States

Pine Seed Bed Study. The "Pine Seed Bed Study" plots which were established in the fall of 1938 were checked in June for the early establishment of shortleaf pine seedlings. Although the results have not been analyzed in detail it is evident that there were more shortleaf pine seedlings on the plots which were seeded artificially than on the naturally seeded plots. The five methods of seed bed preparation were, in order from high to low number of seedlings: (1) Removal of litter and cultivation of soil; (2) cultivation of litter into the soil; (3) removal of litter leaving the soil undisturbed; (4) check; and (5) removal of litter by burning. The pine on artificially seeded plots where the overhead crowns had been opened up were much larger and more vigorous looking than those on unreleased plots and were almost as large as nursery stock of the same age.

Durability of Sassafras Posts. The Station assisted the Laboratory in initiating some durability tests on sassafras posts. Posts for this study were shipped from the Shawnee, Hoosier, Wayne and Cumberland National Forests.

Out of the 100 four to six inch posts cut on the Shawnee, only 9 percent were sound; out of 70 from the Hoosier 31.4 percent were sound; out of 82 selected posts from the Wayne 79 percent were sound. About 50 percent of the smaller trees yielding posts of 3 inch size are cull. The Assistant Ranger on the Shawnee reported that it is very difficult to obtain sound sassafras posts with 4 inches or more of heartwood.

Forest Soils. Soil profile restoration under black locust and sassafras was studied further to include some of the older stands of both species. Data on infiltration rates have been completed to date and show: (1) Infiltration rate increases with high significance

under sassafras in comparison with adjacent abandoned fields; (2) Infiltration rate does not increase significantly under black locust as compared with adjacent abandoned fields; (3) No significant difference was observed in infiltration rates between fields; (4) Sassafras differed with high significance from black locust in infiltration rates.

Northeastern

In connection with the rehabilitation program on the Bartlett Experimental Forest, data are being obtained covering different phases of the damage resulting from the 1938 hurricane. Bartlett was near the eastern edge of the hurricane zone and although maximum wind velocities were not obtained, elapsed time records indicate wind movement was about one-third greater on the Gale River Experimental Forest thirty miles farther west where damage was correspondingly greater.

Exposure of stands to the full force of the hurricane was very important, but exposure of individual crowns appeared to be the determining factor in this region near the outer limits of the hurricane belt. In even-aged hardwood stands distinctly dominant trees were frequently windthrown; losses of fast-growing white ash, paper birch, and aspen were very heavy. Other factors being equal, losses on cutover areas were very much greater than in undisturbed stands. Methods of cutting or degree were of little significance, as breaks in the crown canopy resulted from light or heavy partial removal on an individual tree or groupwise basis. The older residual stands had become somewhat adjusted to changes following cutting and were apparently more windfirm. Probably this was less the result of changes in the larger trees than better anchorage provided by the understory which came in after opening up the stands. This is borne out in undisturbed stands, losses in the upper canopy being considerably less on areas supporting a well stocked sapling stand than on areas containing little or no understory.

Hurricane losses at Bartlett, aside from the very exposed slopes and cutover stands, were largely confined to areas where water had accumulated as a result of more than six inches of rain preceding the wind.

Losses in hardwood stands would have been negligible had the hurricane occurred a couple of weeks later when leaves were falling. Recently girdled trees with few if any leaves and other hardwoods with thin foliage were practically never windthrown.

Only a fraction of a percent of the hardwoods uprooted last September were not alive a year later. A few roots in place were sufficient to produce practically normal leafing; apparently good yellow birch and white ash seed crops were produced on many horizontal trees.

Good progress has been made during the past few months remeasuring plots damaged by the hurricane of September 1938. The two rehabilitation crews which started the checking, cleaning, and remeasuring work in early May, completed the remeasurements of most of the permanent sample plots scattered through the hurricane zone by July 1. Since that time, these crews have been busily engaged in reestablishing and remeasuring some 1,000 odd cruise plots on the Gale River and Bartlett Experimental Forests.

On the Gale River Forest an effort is being made to duplicate as nearly as possible, the 100 acre partial cutting in second-growth spruce which was completely destroyed by last year's hurricane. This experiment is being undertaken in conjunction with a sale to the Parker Young Company for the bulk of the hurricane damaged timber on the forest. Excellent progress is being made by the Company in this extremely difficult salvage operation. Removal of the down timber will not only greatly reduce the fire hazard and facilitate the fire break construction, but will go a long way toward putting the forest in shape for resuming the research program. The CCC crews augmented by WPA crews have made notable progress in this respect. But the end is not yet in sight. It is planned to push the work actively during the coming fall and winter months.

Pacific Northwest

Installment Cutting in Douglas Fir. An opportunity was afforded by the Simpson Logging Company to study the effect of logging by installments in quick succession of a tract of very large, old-growth Douglas fir and hemlock. The company, the Regional Forester's office, and the Experiment Station collaborated in taking detailed records, both from a logging engineering and silvicultural point of view, of the effects of logging this 160-acre tract of company land in five installments. The first cut took out the windfalls, the next only the fir over about 70 inches in diameter, the next the cedar and the smaller Douglas fir, and so on, ending up with a clear cutting. The company was particularly interested in determining the effect on reducing breakage through using this installment method.

From the logging engineering viewpoint valuable information was gathered as to the grade of logs derived from trees which were graded by their external appearances while standing and also data were obtained on logging costs.

From a silvicultural point of view useful informwation was obtained on damage to the reserve stand by each partial felling. A rating was made of fire danger after each successive cut in the plans for which Matthews and Morris participated.

Partial logging Studies in Douglas Fir Region. In the spring and early summer the annual examinations of all partial cutting plots were made. The plots on national forest experimental timber sales received from 20 to 40 percent cuts and have been under observation from 1 to 3 years. Heavy losses of the reserve stand were sustained on some areas while others remained almost static; one area showed a 31 percent loss mostly from insects, another had a 36 percent loss mostly from windfall and had to be relogged, while another area had a loss of less than 1 percent from all causes. One new group of plots was put in during June on the Schafer Brothers timber sale, Olympic National Forest, where scattered, large, sound old-growth Douglas firs are being removed, leaving a reserve of scattered, smaller firs and a heavy stand of understory hemlocks. Many of the trees being removed are over 100 inches d.b.h. and over 250 feet in height.

Light Requirements of Douglas Fir. In order to get some definite data on the amount of crown removal necessary for the establishment of Douglas fir reproduction in connection with selective logging, a controlled shade experiment was started at the Wind River Experimental Forest during the past summer. Shade houses 16 feet square, representing three different light intensities, were built and four check areas were established, one in the open and three under forest canopies. Seed and seedlings were planted in each area and light and temperature records kept through the summer.

Epicormic Branches in Spruce. At the Cascade Head Experimental Forest, where a spruce-hemlock stand was opened up by road construction, Sitka Spruce trees near the opening developed new foliage--epicormic branches--on the part of the bole where the original limbs had already died. A tally was therefore made to determine the extent of this development in relation to the road opening. It was found that within the first 30 feet from the timber edge practically all spruce trees were developing a new, vigorous set of limbs on the bole, while beyond 90 feet all trees were listed as cleared or if epicormic branches had started they were not persisting. This trait of Sitka spruce has considerable bearing on the desirable intensity of selective cutting where quality production is the goal.

Methods of Cutting Study in Ponderosa Pine. In June two permanent sample plots were given their 5-year reexamination. These include the 50-acre plot with its 1,425 reserved trees on the Rogue River National Forest, near the northeast corner of the Crater Lake

National Park, and a 32-acre area on the Deschutes National Forest which also has over 1,400 trees remaining. Both areas had been logged 10 years previous by the standard method of 80 percent volume removal. The measurements, which have not as yet been prepared for analysis, indicate considerable differences in growth rate between these identically treated areas for trees of the same class and age. The Deschutes area showed considerable mortality from windfall during the past five years.

Stand Improvement

Activity on this project has been reduced by the transfer of D. C. Welch to the Rogue River National Forest on July 1.

The study of natural pruning in even-aged Douglas fir by dissection of 100-year-old second-growth trees was completed and the resulting manuscript prepared. Principal conclusions of this study include:

1. No commercially important knot occlusion has yet occured on the sampled trees.

2. On the first 20 feet of the stem no complete occlusion can be expected in the stand sampled for another 10 or more years. After that time a commercially important quality of clear wood will not be laid on for about another 40 years, when the depth of clear will approximate 2 inches.

3. Progressively slower natural pruning and occlusion is likely to occur higher up the bole as branch size and branch age at death increase with increasing height above the ground.

4. Of the occluded knots in the lower 20 feet an average of 60 years elapsed between time of branch death and knot occlusion.

5. Intermediate or suppressed trees are not consistently superior natural pruners.

These findings indicate the need for artificial pruning of Douglas fir stands at an early age if clear lumber is to be obtained in material amounts in reasonable rotations.

Computations were completed on the first remeasurement of the 5 Mt. Walker thinning plots on the Olympic National Forest and on the 3 Martha Creek and 2 Lookout Mountain Road thinning plots on the Wind River Experimental Forest. Fourth remeasurements were made of

the 3 Piedmont thinning plots and of the white pine liberation plot at Wind River. First remeasurements were completed on 3 lodgepole and 5 ponderosa pine thinning study plots at Pringle Falls. Seven new permanent sample plots were located in the Panther Creek piling sale area at Wind River, where last fall stand improvement cutting was accomplished in 100-year-old Douglas fir by removal of trees principally suitable for piling under several methods of marking. During late July and August, Kachin with Mr. Kummel of the Regional Office of Timber Management made a canvass of the stand improvement work possibilities on the Columbia, Snoqualmie, Mt. Baker, Wenatchee, Chelan, and Colville National Forests. Judged on the extent of stands in need of treatment and their accessibility from winter or year-long CCC camps, opportunities of initiating stand improvement projects this fall on all of these forests except the Colville appear favorable.

Southern

Stand improvement

Thinnings in longleaf pine. A brief progress report on the Loxley thinning plots was completed in July. The plots, located in second-growth longleaf pine in southern Alabama, were remeasured for the first time in February 1939, 5 years after establishment. No elaborate analysis was needed or made, but pertinent data for the 4 replications of each treatment were summarized for reference.

The plots were established in 22-year-old stands to determine the effects of thinnings to 3 different average spacings, and of no thinning, on the growth and development of the stands and especially on their value for naval stores. The 3 grades of thinning are defined by the minimum average spacing of the trees selected to be left, and these spacings are 14.7, 12.1, and 10.4 feet, which correspond to 200, 300, and 400 trees per acre, respectively. In each case the marking was done on the basis of leaving the best possible trees with the required average spacing on at least 3 sides or quadrants. The best trees, therefore, were selected at the sacrifice--if necessary--of very regular spacing and of the full number of trees per acre theoretically possible. For this reason, the number of trees per acre actually left was lower than the theoretical number that should be left in all but one instance. In addition to selected crop trees, much smaller and poorer trees were left when they met the spacing requirements and no better trees were available.

Since the main object was to test thinnings that might be suitable for maximum naval stores production (to be evaluated largely on the basis of the number, d.b.h., and d.b.h. growth of

the residual trees at various periods in the future), all 3 thinnings were relatively heavy. It now appears that it would have been desirable to add tests of one or more lighter thinnings, which might well result in the greatest net profit from integrated utilization, including naval stores along with sawlogs, poles, pulpwood, etc.

The accompanying table summarizes the net growth in the past 5 years. Since the two plots have approximately the same site index (No. 1 being only slightly better than No. 2), they are listed alternately in the order of increasing number of residual trees. It will be noticed that with increasing number of residual trees the average d.b.h. growth of all trees and of the 100 largest trees decreases as would be expected, whereas both the actual growth and percentage growth in cords increase. It is evident that the increased growth of individual trees on the more heavily thinned plots has not been great enough, from the standpoint of volume, to offset the severe reduction in number of trees. Inspection of the plots in the field shows that even where the lightest thinnings were made the crown canopy has not yet closed.

Five-year growth in d.b.h. and in cords

Plot No.	Average minimum spacing on 3 sides	No. trees corresponding to ave. spacing used	Actual no. trees left in 1934	Average D.B.H. growth		Average growth in merchantable volume in the residual stand	
				All residual trees	100 largest residual trees		
	Feet			Inches		Cords	Percent of residual cord volume
2	14.7	200	170	1.3	1.3	5.1	85
1	14.7	200	202	1.2	1.3	6.0	102
2	12.1	300	240	1.1	1.3	5.9	109
1	12.1	300	270	1.1	1.3	7.0	104
2	10.4	400	310	1.0	1.2	7.0	113
1	10.4	400	348	1.0	1.2	7.1	109
2)	No Thinning		1,178	0.5	1.2	8.7	142
1)			2,270	0.4	0.9	8.0	118

The present differences between the various treatments with respect both to d.b.h. and to volume growth are likely to continue in the same direction and to increase in magnitude for at least the next 5 years and probably for a much longer period. Even for maximum naval stores production (let alone integrated utilization), the lightest of the three thinnings is likely to prove the best treatment. Where very early returns from naval stores are important, however, the heaviest thinning would naturally be best. Comparisons of the lightest thinning with no thinning are difficult to interpret at the present time. It is thought that the lightest thinning will eventually prove the better, but this is largely a hunch and it is likely that a lighter thinning than to 310-348 trees per acre would prove to be best of all.

Grazing in stands cut-over for pine pulpwood. In the course of the 1937 study of areas cut-over for pine pulpwood within the past 12 years, interesting statistics on the prevalence and degree of intensity of grazing were obtained. The data are based on 500 sample plots distributed over the pine types of the Coastal Plain between Alabama and south-central Arkansas.

Approximately 88 percent of the plots were being subjected to some form of grazing, with a range from 74 percent in the mixed pine-hardwood type to 97 percent in the loblolly pine and in the longleaf pine types. Cattle grazed on 80 percent of the plots; hogs on 55 percent of the plots; and sheep and goats on only 1 percent of the plots. The intensity of grazing was as follows: heavy grazing (about 1 head to 5-10 acres), 34 percent; medium grazing (about 1 head to 10-15 acres), 39 percent; light grazing (about 1 head to 15-25 acres), 15 percent; and no grazing, 12 percent.

The effects of this extensive grazing were not determined, but the figures leave no doubt that grazing is an important factor affecting forest management in the pine types of the deep South.

Southwestern

Harvest Cuttings.

Logging began September 8 on a 480-acre sample plot logged the first time in 1909. The cut contemplates removing about 3,000 board feet per acre on two-thirds of the area and somewhat less on the remainder. The contract sale price is $3.52 per M, $1 of which is set aside for stand betterment under the Knutson-Vandenburg Act. The logs are being trucked to Flagstaff, a distance of 14 miles.

Advantage is being taken of the research opportunities presented by this operation. Diameter measurements have been made every 5 years for 30 years. Individual tree records are available

for a portion of the stand over the entire period of 30 years, and for the entire stand during the last 15 years. All trees have been classified according to the Keen system and also as to log grades, by Thomson of the Regional Division of Timber Management. A defect study of felled trees is being made under the direction of Gill. Another study by Gill applies three degrees of mistletoe control: complete eradication, partial eradication, and no eradication except removal of infected trees in stands of young growth. Each treatment is being repeated on two or more 5-acre plots.

Three methods of cutting are being practiced: (1) a selection method favoring dominants; (2) a selection method favoring subordinates; and (3) a salvage cutting which removes only declining trees which are not expected to live another 30 years. In all three methods, large seed trees figure prominently in the cut because, as a rule, they are declining, commonly from the effects of lightning or mistletoe; their work of restocking the area is finished. Mistletoe trees beyond the degree of "light" are being cut heavily on all three divisions because such trees have a poor change to survive 30 years, and they are a menace to the young generation which has almost completely stocked the area since the first cutting.

Interest centers largely on methods 1 and 2. Under method 1, all yellow pines (class 4) above 30 inches d.b.h. have been marked because records during the past 30 years have shown that in trees of this class mortality equals or exceeds increment. In method 2, yellow pines down to 26 inches are removed. Actually, this difference is scarcely noticeable because there are very few sound trees between 26 and 31 inches anyway. On both divisions, practically the entire remaining stand occurs in groups of 5 to 30 or more trees. Occasionally, as many as a dozen associated groups give the effect of nearly full stocking on units of several acres. Intervening spaces over 50 feet in diameter are nearly always occupied by seedlings or saplings.

The essential difference between methods 1 and 2 lies in the treatment of groups. As a rule the groups consist of nearly even-aged blackjacks or intermediates (classes 1, 2, and 3) spaced too closely for good growth. Despite nearly uniform age, diameters range from 8 to 30 inches. A common arrangement is 3 or 4 large trees in the periphery of the group and a dozen or more smaller ones inside. Usually the outside stems are growing well, but the smaller, inside, subordinates show the effects of intense competition.

In method 1, which corresponds closely to standard Forest Service marking practice, the large dominants are left, unless defective, because they are putting on merchantable increment and they will figure in the next cut 30 years hence. Suppressed and intermediate trees are cut if large enough to make a log but usually the removal of this class does not adequately relieve competition among the subordinate stems.

Method 2 makes a special effort to release subordinate trees, even at the expense of cutting fast-growing dominants. The reason is that these smaller trees, ranging from 8 to 16 inches d.b.h. usually have clean boles or have so few branches that the first log can be pruned very cheaply. Experience shows that they will grow if adequately released. How fast they will grow remains to be seen. Dominants are almost invariably rough and too large for economic pruning. Justification for cutting these dominants, if interfering with smaller trees, is predicated on the belief that a single rough-boled tree over 18 inches d.b.h. will produce less value than two or three clean-boled subordinates of smaller size, if they are released. This method has been called Improvement Selection. Essentially, it is cutting from above for the purpose of improving quality.

Behavior of the groups after cutting will afford a means of comparing the three methods. Obviously a reliable comparison cannot be made on the basis of increment per acre. Perhaps the best criterion is the response of individual trees and tree classes.

FOREST PRODUCTS

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

The results of the 1938 census of production of lumber, lath, and shingles were distributed in August as a mimeographed circular. Western white pine and ponderosa pine were the principal lumber species produced, the combined production being 76 percent of the total. Lumber production in Idaho and Montana dropped from 1,133 million feet in 1937 to 792 million feet in 1938, or a 30 percent decrease. The production of cedar shingles increased approximately 4 percent and amounted to 41,000 squares, which are sold principally in eastern Washington, Idaho, and Montana.

Decreased volume production was accompanied by a decrease in lumber prices. Cedar was the only exception, showing an average selling value of $29.77 for 1938. This high price was due to sales of abnormal amounts of D and better select and excess stock accumulations of Nos. 4 and 5 common lumber. Adjustments for these factors result in a price of $26, or about $1.50 in excess of the 1938 ponderosa pine price.

Products-economics statistical work was analyzed project by project during Steer's visit to the station. As a result, objectives of each project were clarified and differences in procedure reconciled and correlated with the national viewpoint.

TIMBER HARVESTING AND CONVERSION

Northern Rocky Mountain

Log and Tree Grades. A mimeographed resume of the development of ponderosa pine tree and log grades at the Northern Rocky Mountain Station has been prepared as a preliminary step in the standardization of grading ponderosa pine in the log or tree. Comments have been received on it from several individuals in anticipation of a conference of interested western experiment stations. Log and tree grades developed at other stations are also being studied at this station.

Deception Creek Milling Study. About 90,000 feet of white pine logs from the Deception Creek Experimental Forest were studied at the sawmill of the Ohio Match Company, Coeur d'Alene, Idaho. The timber studied was mature, average in size, but below average in quality. That the timber was poor in quality was known beforehand. All of the logs came from trees which had been cut for silvicultural reasons. The operation resulted in a removal of about 20 percent of the stand volume, taking only those trees which were the least promising and were likely to die earliest. The aim of the milling study was to obtain lumber yields and conversion values for this class of material.

Though the results of the milling study are not yet available, the study up to this time has demonstrated that it is feasible, from a logging standpoint, to make a 20 percent cut in a stand of western white pine. Plans are now under way to make further light cuts in the Haynes Creek drainage of the Deception Creek forest. This drainage has been set aside as a demonstration area for selective cutting in western white pine.

Close Utilization on Deception Creek Experimental Forest Cuttings. Just completed on the Deception Creek Experimental Forest is a cutting that indicates what can be done with good utilization roads. Through the procedure of administrative use, salvage of 710 M feet of dead, dying, and unhealthy timber, mainly western white pine, was accomplished on an area of about 250 acres. It was estimated that all of these trees would have been totally lost within a period of not more than 5 years. In getting out this timber, the contractor built

2.1 miles of road, costing $2,553, on Forest Service specifications that is a valuable addition to the utilization road system on the forest. The operator also paid into a special cooperative work fund 50 cents per M board feet cut to cover the cost of necessary slash disposal along roads and some supplementary stand improvement work. In making this cutting, a silvicultural improvement of the stand was effected, timber that otherwise would have been lost was put to productive use, and the value of the remaining stand was augmented through increased accessibility.

Included in this cutting was 50 M feet of Douglas fir and western larch timber cut in road construction (the balance cut was western white pine). This marks the first time these species have been utilized as commercial sawlogs on the forest and brings the much cherished hope of commercial utilization of all species that much nearer reality.

In making this salvage cutting, the operator used horses to skid an average distance of about 350 feet to two utilization roads built on contours from 500 to 700 feet apart on the mountainside. Loading was done with a jammer which was also used to skid logs within 100 to 150 feet above and below the road. Logs were trucked to Coeur d'Alene, 26 miles distant, on light trucks averaging about 2,600 feet per load. Hauling was contracted at $4.50 per M. This operation demonstrated the practicability of making light cuts - a little less than 3 M per acre in this instance - in western white pine stands, something that has seldom been done before. A milling study on a sample of the logs from this cutting was made, as reported elsewhere.

A sale of 70 M feet, netting $3 per M for stumpage and 50 cents per M for slash disposal, has recently been made to salvage all white pine trees on the forest currently bug-killed, dying, damaged by road construction or broadcast-burning operations, etc., that are within easy skidding distance of some road. This type of sale has become practically an annual affair on the forest. When the forest road system is completed it will be possible commercially to utilize practically all current mortality in merchantable species.

Pacific Northwest

Selective Timber Management in Douglas Fir. Following a month's vacation, Brandstrom returned to duty early in July and has since been devoting most of his time to a study of installment cutting on the operations of the Simpson Logging Company of Shelton, Washington--a study which was undertaken at the request of the logging company. This study divides into two main parts: the silvicultural, which is being conducted by the Division of Forest Management Research, and the logging economics part, which is being handled by Brandstrom assisted by Flanagan of the Regional Office.

The study area embraces 160 acres of old-growth timber, cruising approximately 16 million board feet. About 75 percent of the total volume consists of an even-aged overstory of Douglas fir over 500 years old and ranging mainly from 5 to 8 feet in d.b.h. The remaining 25 percent consists mostly of an uneven-aged understory of hemlock, ranging up to about 5 feet in d.b.h. and 400 years of age.

On this area actual logging was started early in July with the salvage of over a million board feet of merchantable windfalls. Then followed a cut of generally large Douglas fir trees, and later another cut of medium size and smaller trees of the same species. At the present time a third cut is under way, the bulk of which consists of the large hemlock trees. Following this cut, a fourth and final cut will be made which will consist mainly of small hemlock. The end result will be clear cutting, but with a selective procedure of cutting behind it. With each of these so-called installment cuts go detailed studies of fire hazard and logging damage to the "reserve stand", as well as studies of outputs, costs and returns as affected by size and character of timber and volume of each successive cut, etc. Another important phase is the study of breakage as affected by repeated cuttings, instead of the conventional form of clear cutting where all the timber is cut and logged in one fell swoop.

From the logging economics point of view the most significant feature of this study is the opportunity it affords for experimentation with different systems of log grading of standing trees and of testing their accuracy. Over 1,000 Douglas fir veterans, with an average volume of more than 10,000 board feet each, have here been taped, numbered, tagged, and log-graded prior to falling, both on the basis of surface grades and on the basis of the standard commercial grades. Logs from these trees, properly identified by tree numbers and by their position in the tree, are reported by the Puget Sound Log Scaling & Grading Bureau for each raft as sold by the company to the log buying mills. From these records the logs are listed and reassembled tree by tree, showing the gross and net scale and the final grade of each log. In this manner the complete story is now being assembled of estimated grades and volumes of logs in the standing trees and the corresponding final scale and grade of the same logs as finally sold on the log market. From this will later be determined the average fall down in scale and grade for logs of different sizes and qualities, and an analysis made of the relative merits of the two log grading systems used and of errors of estimate for different log grades. This is the first time a study of this sort has been undertaken in this region and so is being followed with utmost interest from all parties concerned.

Pine Mill Studies. Computations on the combined report for the 6 pine mill studies made since 1935 have progressed satisfactorily. But due to the large amount of time spent on program conferences, no results have been put in final shape.

A study at the J. Neils Lumber Co., Klickitat, Washington, was undertaken, the field work completed, and the first assembly of the data begun. This company requested an analysis of log values because it is planning to cut on a selective basis--probably about 50 percent volume removal with economic maturity and silviculture both being given consideration in the selection. The company is now operating in a mixed ponderosa pine-Douglas fir stand where the pine is of lower quality than any yet studied. It was deemed desirable to obtain data on such timber and to see whether results obtained in the better stands in Oregon could be used in predicting log values and lumber-grade recoveries in such timber.

Depletion. Sawlog depletion for 1938 in both the Douglas fir and ponderosa pine regions of Oregon and Washington was compiled by Johnson for the purposes of the Forest Survey. The compilation showed depletion by counties and by species. Although these compilations are based in large part on information obtained in taking the annual lumber census, first-hand knowledge of individual operations is essential in interpreting the data, especially that for the Douglas fir region. During the past several years, a large increase in the number of small operators, both independent and contract, has added to the work involved in bringing these data together.

WOOD PRESERVATION

Northern Rocky Mountain

During the fore part of September, Whitney and Wirka of the Madison Laboratory completed a field inspection and office analysis of all current wood service tests carried by the Northern Rocky Mountain Station. Special emphasis was placed on the correlation of work being done here with that of the Laboratory. Attention was also given to the standardization of field and office procedure.

Several field inspections of Anaconda treater dust and paste were made by Whitney and Wirka. The Bozeman-Flathead telephone line in Bridger Canyon near Bozeman, Montana, treated 9 years ago with paste, indicates an average life at this time of 12 or 13 years, which means that the service life of lodgepole pine poles is almost doubled.

Pacific Northwest

Arsenic Paste Service Tests. In June, the Division of Forest Products made the biennial inspection of arsenic paste test lines located in Washington. No conclusions as to the efficacy of this preservative can yet be drawn because of the contradictory results obtained. For example, in one line where both seasoned and unseasoned poles were used, rot was found in a high percentage of the unseasoned poles while the seasoned poles were sound. In other lines this difference has not been evident and it will require more time in service to determine whether the variations in life result from seasoning or whether soil and moisture conditions are the influencing factors. Although in most cases the paste seems to be adding to the life of the poles, it is not yet apparent what the additional life will be or whether it will be enough to justify the use of paste instead of creosote.

Two new arsenic paste tests lines made up of treated and untreated poles set alternately were established and will be inspected. These will allow direct comparisons with untreated controls, a very desirable factor that was impossible to incorporate in the original tests in which only poles already installed could be used. Lack of accurate records on untreated poles then in use eliminated them from the tests.

Southwestern

Fence Posts. A series of nine test fences was established in representative parts of the Southwest last winter to determine average service life for untreated posts of the four native junipers and for posts of smooth cypress (Cupressus glabra), both treated and untreated.

Since the results of this study will not become available for many years, a survey of untreated juniper and cypress posts in existing fences of known age was made during July to furnish data for current use. Approximately 2000 posts in 65 fences which varied in age from 5 to 50 years were examined. Measurements of the outside diameter and width of sapwood were taken on each post. Serviceability was determined by resistance to a 100-pound pull with a spring balance. The data have not been compiled or analyzed as yet but the average service life of juniper posts of all species was found to be exceptionally long under all the combinations of climate and soil encountered.

The service life of individual posts seemed to vary in general with the size of the heartwood core. Ten of the fences examined contained cypress posts. With this species, however, there does not seem to be a definite relationship between size of heartwood and durability.

In order to obtain reliable answers to some of the questions, a supplementary study was initiated in August to determine the effect of peeling, seasoning, and season of cutting on the durability of posts of cypress, Utah juniper, and Rocky Mountain white oak. Five posts of each species will be planted green and unpeeled, five green and peeled, five seasoned and unpeeled, and five seasoned and peeled. To test the effect of season of cutting, five posts of each of the three species will be cut and planted green and unpeeled during September, and similar sets in December, March, and June.

The tire tube method of fence post treatment has been recommended by the Forest Products Laboratory as an inexpensive and effective method for impregnating the sapwood of green fence posts with water soluble salts such as zinc chloride. The method was used during August for treating five posts each of the nine following southwestern species:

Pinon pine	Smooth cypress	Alligator juniper
Ponderosa pine	Rocky Mountain white oak	One-seed juniper
Aspen	Rocky Mountain red cedar	Utah juniper

Several differences were observed in the case of treating the nine species. The posts of ponderosa pine, pinon pine, aspen, smooth cypress, and Rocky Mountain white oak were uniformly round in cross-section, fairly straight and contained few large knots. In contrast the junipers were very irregular in cross-section, with prominent ridges and deep grooves and contained many large knots on the surface. Although the first five species were easily prepared for treatment, it was necessary to trim the butt ends of the junipers with a drawknife to obtain a smooth round surface. This operation often cut away considerable portions of the sapwood at the butt end and required more time and labor. In treating the junipers, moreover, a large proportion of the cell sap and treating solution dripped from the knots instead of passing through the entire length of the post. The treating solution penetrated the sapwood of some species much more quickly than others. Posts of ponderosa pine, pinon pine, and aspen were treated in less than 24 hours, those of smooth cypress and the four junipers required about 48 hours, and some of the oak posts have required 10 or 12 days.

The treated posts with an equal number of untreated posts, and the posts for the study of peeling, seasoning, and season of cutting will all be planted in a randomized block arrangement on a uniform area near the Fort Valley headquarters. Each treatment will be replicated five times. The posts will be planted in rows 5 feet apart with the posts 5 feet apart in the row. They will be examined annually to determine service life.

FOREST AND RANGE INFLUENCES

FLOOD CONTROL SURVEYS

Allegheny

Preliminary Examinations

The preliminary examination report of the Pequest River is in first draft. Both the State of New Jersey and the U. S. Engineers have authorized examinations of the Pequest, and the factual material from our report is to be made available to them. The line between drainage and flood control remains to be clearly drawn in this watershed and there is a possibility that a joint survey may be conducted, as cooperative relations with the U. S. Engineers are now at a stage where joint procedure may be desirable and possible.

The preliminary examination report of the Allegheny River has been completed, and a survey has been approved for this watershed, which is of high importance in the entire Upper Ohio Basin.

Watershed Surveys

First drafts of the reports of the Cedarus Creek, Buffalo Creek, and Youghiogheny River have been completed. These three reports are in various stages of being evaluated, reviewed, and edited. The Cedarus Creek Report failed to show any significant forestry problem except for some reforestation on a few steep eroded areas. The evaluation of the measures suggested for the Buffalo Creek must await the completion of a detailed survey by the U. S. Engineers.

The Youghiogheny River Report showed that (1) the most serious floods on this watershed occur in winter or early spring; (2) the effect of vegetative and land use measures on reduction of winter flood flows cannot be definitely determined with the data available; (3) mechanical measures provide the most effective means of reducing winter flood damages; (4) summer floods are of minor importance but give more promise of correction than do winter floods.

Work outlines have been completed for the watershed surveys of the Allegheny and Upper Susquehanna Rivers.

Infiltration studies have been started on the Youghiogheny and several other watersheds but have not progressed to the point of providing usable results. The work on run-off analysis from experimental areas is making possible the evaluation of changed land use in terms of flood flow reduction.

Appalachian

Preliminary Examinations

The preliminary examination report for the 4,565 square miles of drainage above the proposed Bluestone Flood Control Reservoir was completed and submitted to Washington in July. Preliminary examination work on other watersheds has been greatly curtailed by the demands on regional personnel for other flood survey work.

Watershed Surveys

During September flood control survey work on the Coosa River watershed above Rome, Georgia, in which the Station is cooperating, was completed and the report on this project prepared.

During August and September a survey work outline for the Potomac River watershed, above Washington, D. C., was made, and the Station assisted in preparing a similar work outline for the Pee Dee watershed. Preliminary arrangements were made for initiating flood control surveys on these watersheds and it is anticipated that operations will be started at an early date.

A survey work outline is now being prepared for the New River watershed above the proposed Bluestone Flood Control Reservoir, and should be completed in the very near future.

California

Preliminary Examination Reports

A preliminary examination report covering the Madera-Fresno-San Joaquin group of 2200 square miles was forwarded to Washington in July. Reports now in progress include the Walker River Basin, 4,000 square miles; the Santa Ynez River Basin, 900 square miles; the Santa Clara River Basin, 1,620 square miles; the Russian River, 1,670 square miles; and the Eel and Mad Rivers of 4,177 square miles.

Preliminary survey investigations were suspended temporarily on August 3 to permit the formulation of tentative survey work outlines for the following basins: Pajaro, 1,290 square miles; Kings-Kaweah-Tule-Kern, 12,150 square miles; Santa Maria, 1,875 square miles; Upper Sacramento, 6,590 square miles; Salinas, 4,980 square miles; Merced group, 828 square miles.

The survey work outline for the Pajaro was forwarded to Washington on September 8. Outlines now in preparation are the Kings-Kaweah-Tule-Kern and the Santa Maria.

Central States

Preliminary Examinations

The preliminary examination reports on Yellow Creek, Ky. and Tenn., and Nonconnah Creek, Miss. and Tenn., were completed and sent to Washington in July. Both were negative reports. The preliminary examination report on Wolf River, Tenn. and Miss., is nearly finished.

Contributions have been made in the preparation of preliminary examination reports for the Wabash River, Ohio, Indiana, Illinois; Iowa River, Iowa; and Little Sioux River, Iowa. The S.C.S. has chairmanship of these three watersheds.

Assistance has been given in preparing survey work outlines for the Licking River, Ky.; Mad River, Ohio; Boyer River, Iowa; North Fabius River, Missouri; Chariton River, Iowa and Missouri; and the Weldon River, Iowa and Mo. All are under S.C.S. chairmanship and are nearing completion.

Watershed Surveys

St. Francis Survey. Practically all of the field work has been completed on the St. Francis Survey. The Survey Report is nearing completion. A six weeks' extension, beginning October 31, has been requested from Washington.

Muskingum Survey. The Muskingum Survey has asked for an extension to July 1, 1940. A unit report is being considered for Raccoon Creek, Licking County, Ohio. Only about one-fourth of the watershed has been completely surveyed. Infiltrometers have been received and organized field operation began during the last part of September. The forestry section on the Killbuck Watershed has been completed and work is now being done on the forestry section for the Licking Watershed. Assistance has also been given in the collecting of cereal harvest from sample yield plots.

Intermountain

Watershed Surveys

Boise River. The Boise River Watershed Survey project has completed practically all field work and is now concentrating on the compilation and analysis of data for report purposes. Some of the major field jobs which were completed in August and September included a treatment estimate survey, a determination of infiltration capacities, and a compilation of land use and flood-silt damage values.

Estimates of the kind and amount of remedial measures needed on the watershed lands and in the channels of tributary streams are being developed jointly by plant-soils men and engineers. Optional programs are to be developed from these data in keeping with cost-benefit ratios.

By arrangement with the U. S. Corps of Engineers, the Survey project has assumed the primary responsibility for developing land use and flood damage data, which is now largely complete. The Engineer Corps has completed a detailed physical survey of the flood plain and will furnish the project with a delineation of flood plain zones of different flood magnitudes. Hydrologists of the Corps of Engineers and the Survey jointly developed a schedule of expected flood frequencies and magnitudes which is being used in all cost-benefit calculations.

Two of the most important field data gathering jobs which remain to be done include recross-sectioning of storage areas behind Diversion and Barber Dams to determine silt deposition and continuation of the stream gaging and silt sampling effort by the U. S. Geological Survey.

Preliminary Examinations

Field inspection for the Weiser River preliminary examination report has been completed and a rough draft report is now being assembled for committee consideration.

The examination report on the Sevier River watershed has been enlarged in scope so as to include the entire Sevier Lake drainage basin. This has required a recapitulation of basic data which is now nearing completion. It is expected that a draft of the revised report will be ready for committee consideration in October.

Lake States

Field work on the Kickapoo has ended and work on the report is nearly completed.

Work on the Whitewater Survey was begun about the middle of September. A series of recording and standard rain gages was established on the watershed and arrangements were made with the Geological Survey for the installation of a very complete system of stream-gaging stations. Plans are being made for an infiltration study using the North Fork apparatus.

The Station has been working in close cooperation with the Water Consultants of the National Resources Board of this region in an effort to evolve a sound program for all activities involving water use.

Merrimack Watershed

The analysis of flood hydrographs for several severe floods indicates that not only the volume, but also the timing of the discharge from the various tributaries, is an important factor in producing flood peaks on the main river which cause the heavy losses in the downstream reaches of the river. This suggests the possibility of desynchronizing the discharges of the several tributaries in such a way that they do not tend to pile up in the main stream and cause a severe flood.

Improved land management in the headquarters, in addition to providing increased ground water storage to hold over a portion of the flood water to be discharged during periods of relatively low water, may also provide a means of desynchronizing flood flows from different areas by differential retardation of the storm runoff. For example, a well developed forest soil on an area may permit all the storm water to filter through the surface, and in cases where the subsurface storage capacity is completely filled the water will be discharged as wet weather springs. This water, because of the delay involved in flowing through the surface layers of the soil, may in many cases reach the streams after the surface runoff from cleared areas has already passed downstream, thus lengthening the period of runoff on the tributary. In case of spring floods the differential effect of land management measures on snow accumulation and soil freezing may tend to distribute the runoff of a spring storm over a longer period than might occur in a watershed with uniform land management. It may also be possible to discharge tributary peaks into the main river ahead of or behind the main river peak by means of land management measures.

Although the possibilities of manipulating cover to distribute flood runoff are being carefully studied in connection with the survey, it will be impossible to make specific recommendations because of the absence of any experimental data concerning the effect of cover and land management on the timing of runoff which are applicable to conditions on the Merrimack.

Pacific Northwest

The preliminary flood control report for the Willamette River was completed and sent to Washington in August. The work outline for the Walla Walla River watershed has been completed and will soon be

sent to Washington. The first rough draft of the work outline for the Williamette has also been prepared. A preliminary flood control report for the Puyallup River is in the course of preparation.

Rocky Mountain

Fountain River watershed. The detailed survey report of the Fountain River watershed in Colorado has been submitted to the Washington office for review.

Washita River survey. Field investigations of the Washita River survey in Texas and Oklahoma were completed during the latter part of August, and the survey personnel transferred to the Grand-Neosho River survey with headquarters at Parsons, Kansas; to the Cherry Creek survey in Colorado; and to the Regional Office of the Soil Conservation Service at Amarillo, Texas. The Washita River survey report is now being reviewed by the Field Working and Coordinating Committees and should be available for transmittal to the Washington Office during the latter part of October.

Cherry Creek survey. Field investigations of the Cherry Creek survey, which have been in progress since last April, will be completed in November and the report will be ready for Field Committee reviews early in December.

Detailed surveys. Work plans for detailed surveys have been made for the following watersheds: Yellowstone River in Wyoming, Montana, and North Dakota; Big Horn River, a tributary of the Yellowstone in Wyoming and Montana; North Platte River in Colorado, Wyoming, and Nebraska; Cheyenne River in Wyoming and South Dakota; Bear Creek, a tributary to the South Platte River near Denver, Colorado; Wolf Creek, in the North Canadian River basin in Texas and Oklahoma; the Salt Fork of the Arkansas River in Kansas and Oklahoma; and the Purgatoire River, a tributary to the Arkansas in Colorado.

Republican, South Platte, and Smoky Hill Rivers. Preliminary examinations of the Republican and South Platte Rivers in Colorado, Wyoming, and Nebraska are well underway, and the preliminary examination report of the Smoky Hill River in Colorado and Kansas is being reviewed by the Field Committees.

Southern

Preliminary Examinations

This office assisted in the preparation of a supplement to the preliminary examination report on the Lower Arkansas River basin; the supplement considers two tributaries partly in Arkansas and partly in Oklahoma which had hitherto been unconsidered due to uncertainty of survey region boundary lines, etc. In pursuance of current policy, no further work is being done on preliminary examination reports.

Watershed Surveys

New survey territory has been added to the Southern Station's responsibilities, which involves us immediately in the now-going Grand-Neosho River survey (Oklahoma, Kansas, Missouri, and Arkansas), and in the White River survey (Missouri and Arkansas) at an early date. We have assisted in the preparation of work plans for Grand-Neosho survey and have taken steps toward setting up the White River and Lower Arkansas surveys. This Station has the chairmanship of the White River survey.

The Little Tallahatchie River survey report is rapidly nearing completion. Oxford, Mississippi, will remain headquarters for the survey party which will initiate work at once on the Yazoo River survey. The Trinity and South Concho River surveys, in which we have cooperated, are also nearing completion. The South Concho River survey party will be the nucleus of the Middle Colorado survey and our Trinity technicians will be likewise distributed between the Grand-Neosho and Lower Colorado surveys.

Southwestern

Preliminary Examinations

Examinations for all the more important drainage basins have been completed, including subdrainages as Santa Cruz and Upper Gila of Gila River and Upper South Canadian of Canadian River.

Watershed Surveys

Field work on Upper Gila in New Mexico and Arizona above Coolidge Dam is practically complete; compilations of data are well along and

report preparation begun. An interim report was submitted on the Upper Rio Puerco and work on the entire Puerco drainage is well advanced. (Rio Puerco is an important flood and silt contributing tributary of Rio Grande above Elephant Butte Dam.)

Survey of the Pecos River in New Mexico and Texas was begun in September. A field office for the survey has been set up in Roswell, N. Mex. Glenton Sykes, formerly on the Parker Creek field station staff, is chief engineer on the field party.

Pecos flood control survey data also will constitute the main contribution of the Department of Agriculture in the interdepartmental investigation of Pecos basin problems being conducted through the National Resources Planning Board. This investigation is predicated on the fact that the Pecos admittedly is one of the most complicated problem areas of any large river basin in the West. River waters have been over-appropriated for irrigation in both New Mexico and Texas. Water rights are further complicated by the old, United States recognized, Spanish and Mexican acquired rights in the northern part of the basin and by the development of ground, artesian, pumping, and natural spring water supplies. Water quality is a serious problem also because of saline deposits, salt springs, and silt. Mining, although whether it is a factor or not is yet to be determined, has become involved in this salinity question because of extensive potash mining. Aside from the complex intra- and inter-State problems of water rights and of salinity which have been carried to the courts from time to time, the Pecos also presents unusually important land use, social, and economic problems that are directly concerned in any consideration of protective watershed management. Furthermore, almost all the different common and uncommon problems found on any western watershed are grouped here and are important. Such problems include those of vegetation and soil depletion on range and timber lands, flood damage to town and agricultural property, siltation, water storage, channel control, irrigation diversions, drainage, consumptive losses on river bottom but unfarmed lands, channel losses, salt and gyp springs, soluble mineral deposits, mining, stream flow, ground water, pumping, and artesian and big spring developments.

INFLUENCE OF NATURAL VEGETATION ON STREAMFLOW

Appalachian

Streamflow Measurements. Two modified Columbus deep-notch controls have been recently completed on the Coweeta Experimental Forest. This stream-gaging device was designed at the Appalachian

Station to meet the need for accurate stream gaging under a wide range of conditions. The modified Columbus deep-notch control consists of an ogee section having a crest shaped in the form of two arcs of an ellipse to form a deep central notch. The crest is extended on straight lines with a slope of 1:5 for 2 feet on each side of the elliptical segment then on a slope of 1:10 to any desired distance. To measure the peak discharges expected from small drainage basins usually gaged in the study of forest influences, three sizes of openings have been selected for pre-rating. The width of the control is established by constructing vertical walls normal to the crest to obtain a symmetrical flow section with a maximum head above the notch of 5 feet. These walls, which extend 2-1/2 feet downstream, are rounded at the upstream edge to form a smooth curve joining the cut-off wall, which establishes hydraulicly sound entrance conditions. The sizes now being rated at the National Bureau of Standards Hydraulic Laboratory are 6 feet, 15 feet, and 24 feet, with estimated capacities of 200, 550, and 900 c.f.s. at a head of 5 feet. Arthur, of Engineering, and Sims and Hertzler, of the Division of Research, are representing the Forest Service in developing the new stream-gaging device.

Tests of the 6-foot control have been completed and show satisfactory performance in the laboratory. The advantages of this type of installation are: a non-silting ogee control permitting measurement of all flows except those laden with large debris; accuracy of measurement over a wide range of discharges; a predetermined rating table; and low field maintenance costs.

An "Outline for compiling precipitation and runoff data from small drainage areas" was issued during the summer as Station Technical Note 34. The outline describes a procedure for the systematic compilation of data for continuous records of precipitation and stream discharges. It includes instructions for compiling standard rain gage records, weighted mean precipitation on a drainage basin, recording rain gage records, weighted precipitation rates for individual drainage basins, runoff records, drainage basin discharge data, and summaries of rainfall and runoff.

Wherever they are applicable, the approved forms adopted by the San Dimas conference committee on standardization are used. The outline will be expanded to include procedures for compiling soil moisture and water table fluctuations. A second outline for analysis of hydrologic data obtained from small drainage basin studies and the application of these analyses to forest and other land-use management practices is now being assembled.

Analysis of Drainage Area Data. A North Carolina State W.P.A. research project for the compilation and analysis of drainage area data has been active since July. This project provides 20 skilled

workers under the direction of a supervisor, and has the definite objective of completing a study of ground water retention and depletion on small drainage areas. Compilations are made to obtain the daily mean c.f.s. per square mile. From this the monthly ground water depletion in area inches is obtained. Compilations of monthly precipitation in area inches are also made. A final report on the project will be made at the end of the year.

California

Watershed studies. A continuous record of flow from the spring in Fern Canyon is yielding interesting results. This record which started the latter part of May showed a steady decrease in spring flow until about the end of the first week in July at which time the curve levels out and shows a slight upturn. This is especially noteworthy despite the fact that we had had no rainfall since April and the spring is only 500 feet below the top of the watershed. Records of the flow from the springs supplying Tanbark Flat will be started as soon as possible.

The San Dimas large lysimeters continued to yield seepage despite the fact that the last appreciable rain of the season occurred on April 1. The average seepage rate in terms of surface inches has dropped from about .02 inches daily to a trifle less than .01 inches.

The large, unconfined and root study lysimeters were profiled to determine the amount of soil settlement during the past year. A preliminary inspection of the level notes showed that the soil in the large lysimeters has settled approximately 0.5 foot during the two years they have been in operation, more than 0.4 foot having occurred the first year.

A study has been initiated to compare evaportations, using pairs of Bates evaporimeters. One pair is located at the climatic station in the lysimeter area, which is in the open; while another pair has been set under the natural chaparral canopy a short distance away. Two other pairs have been set up on the Fern Canyon burn. One pair of evaporimeters is exposed at the Fern Climatic Station at 5100' elevation which is in the midst of the burned area; while the other pair will be located in the nearest unburned chaparral.

A record-breaking heat wave starting September 17 was abruptly terminated on September 24 by a record-breaking storm. During the period September 24 to 27, over five inches of rain were recorded in Los Angeles. This was the largest September storm ever recorded since the establishment of the Los Angeles branch of the Weather Bureau. On the San Dimas Experimental Forest, the rainfall

ranged from a minimum of 2.98" to a maximum of 12.98". Rainfall on the Fern Small Watersheds which were burned off in November 1938, averaged slightly over 10 inches. Heavy intensities were very spotted. During the first hours of the storm a maximum intensity of 2.64 inches per hour for a ten-minute duration was recorded in Dalton Canyon. In Fern Canyon a short burst of as high as two inches an hour was recorded, but lasted only a few minutes. The average intensity over a long period was approximately .30 inch per hour and caused but a small amount of runoff. The rain in Fern Canyon was accompanied by violent gusts of wind. The Fern Small Watersheds produced very low runoff peaks considering the recent denuded condition of the watersheds. This was due to the absence of any sustained heavy intensities. Amounts of eroded material reaching the small reservoirs in these watersheds were negligible.

The Fern SRE Plots yielded some extremely interesting figures upon rainfall-runoff relations. Long steady periods of rain at the rate of three-tenths inch per hour produced runoff at the rate of two-hundredths inch per hour, six-tenths inch per hour of rain produced runoff at the rate of eight-hundredths inch per hour, and two inches per hour rain produced runoff at the rate of .24 inch per hour. The duration of the .6 inch per hour and the two inches per hour was so short that uniform runoff from the entire surface of the plots was not attained. Erosion from the plots was comparatively low.

The Barranca quadrats in a thirteen-year-old burn showed little change since 1938. Two of these plots were burned in the Waterman fire of November 1938. The Waterman and Cholo Point quadrats escaped this fire.

On Fern Canyon runoff plots, burned in November, 1938, practically all of the oak stumps have sent up sprouts. There is a fair cover of herbaceous species, mainly Phacelia brachyloba, Nama parryi, and Lupinus longifolius. Also there is an abundance of seedlings of Ceanothus integerrimus. The mustard planting on Plot 347-349 of the Fern Canyon series was not very successful, due probably to the northerly exposure of the plots. Germination was good but the plants never constituted much cover. The seed crop was good, however, so there may be a better cover next year.

Four new milacre vegetation plots were established in the Fern Canyon burn to study succession. Two of them were located at the site of an old wood rat's nest to show the effect of these habitations on succession. This season the locations of former nests show a conspicuous absence of vegetation. There is a question whether the heat of the nest burning killed the seed or whether some other factor, possibly the heavy ash, prevented it from germinating.

The San Dimas SRE plots have not been burned since 1936. The sprouting shrubs such as Quercus dumosa, Rhus Diversiloba, Pentstemon cordifolius, and Symphoricarpos mollis have increased in spread. Bromus rigidus and Bromus rubens have crowded out practically all of the other species of annuals.

The Watershed Erosion Control Plots were all examined and show no evidence of erosion for the past rainy season.

The shrub plantings on the slopes around the San Dimas lysimeters made during 1938 and 1939 were examined in detail and the individuals tagged. Most of the shrubs were planted during February 1939. However, the following summary of survival includes individuals planted during both seasons.

	Alive Feb. 1939	Percent Survival, July 1939
Acacia karo	20	55
Adenostoma faciculatum	91	76
Ceanothus oliganthus	18	89
Diplacus longiflorus	171	82
Fraxinus dipetala	21	5
Oliva vercicossa	23	78
Pentstemon cordifolius	139	59
Pentstemon termatus	162	33
Photinia arbutifolia	44	84
Prunus ilicifolia	99	66
Quercus douglasii	18	61
Quercus dumosa	174	56
Rhamnus crocea ilicifolia	40	82
Rhus integrifolia	32	100
Rhus laurina	92	92
Rhus ovata	125	94
Salvia sonomensis (1938)	4	100
Zauschneria californica	11	100

On the whole, the three species of Rhus have shown the best development and growth as well as the highest survival percent. Salvia sonomensis, a prostrate plant, is worthy of mention, even though there are only four individuals concerned. The spread of these plants after two years growth averages 20 x 30 inches. The maximum individual has produced a thick circular mat four feet in diameter.

The growth of shrubs, as in previous years, has been decidedly inhibited by presence of grain. The best survival (100 percent for the species of Rhus and Quercus dumosa) is on an area without any grain or other competing plants.

Model Studies of the San Dimas Type Flume. The check runs of the clear water studies of the San Dimas type flume being carried on at the Hydraulic Laboratory of the University of California, and reported on in the Bi-monthly report of June 2 (page 57) have been completed. These runs were designed to verify original results with the half-scale model of the one-foot flume, using various floor slopes and friction conditions. Verification has been within a range of about 3 percent.

Two other series of experimental runs with clear water were initiated and completed since the last report. One series was designed to determine the effect on the rating formula of various approach channel slopes from level to 7 percent. The second series was designed to determine the length of flume on the rating formula and included studies of flume lengths from 36 inches to 6 inches. In both studies a wooden half-scale model of the one-foot flume was used and had the following dimensions:

Floor slope - 3 percent
Stillwell slots in the center of the flume
No added friction
Inlet transition from 2W to 1W, using a curvature of 2W where W = the width of the flume.

Intermountain

Farmington Experimental Watersheds. A much needed construction and improvement program on the Farmington experimental watersheds at the Wasatch Branch Station was initiated in July with WPA funds. The program includes the installation of five new gaging stations, the standardization of the approach to and field calibration of eight old and five new gaging stations, the enlargement of the collector tanks on sixteen surface runoff plots, the extension and improvement of service trails, and landscape improvements at the Farmington Canyon substation.

One of the new gaging stations will be installed near the mouth of Farmington Canyon while the other four will be constructed on four "north side" tributaries. These new stations together with six already installed on "south side" tributaries, will provide for complete integration of runoff from the Farmington Canyon area, except the extreme headwaters.

Plant cover, litter, and soil conditions on approximately 800 of the 1,600 sample plots on the "south side" tributaries of Farmington Canyon were recorded during July and August as a part of the plant-soil inventory on the experimental watershed.

The U. S. Weather Bureau has provided two snow gages for installation on the Farmington Canyon experimental watersheds. The snow gages are to be incorporated in a revised plan for getting winter precipitation records with a view toward reducing the hazard of snowslides.

Stream Flow Data Compilation Project. A compilation of stream flow, precipitation, and temperature records at the Wasatch and other branch stations was initiated in July as a WPA project. This effort will convert field records into convenient tabular form for analysis purposes.

Contour Trench Infiltration Study. As a guide for planning an extension of contour trench work in this region, an exploratory study of the infiltration capacities of different size contour trenches on different soil types was initiated in September. In this study water is applied to sections of contour trenches and absorption is measured against time. The first phase of the study was made on heavy soils derived from limestone at the Great Basin Branch. Replicate measurements will be made on the lighter, gneiss-schist, soils at the Wasatch Branch. Although the field tests have not been completed, indications are that infiltration rates are sufficiently variable because of soil differences to warrant careful consideration of this factor in planning contour trench operations on new work areas.

Infiltrometer Study. A study to determine the factors influencing infiltration on mountainous granitic soils and to test the adaptability of the newly developed North Fork Infiltrometer was initiated in August at the Arrowrock Substation. Measurements with this apparatus made in connection with the Boise River Flood Control Survey indicated such a high variation in the infiltration capacity of granitic soils under controlled conditions of cover, slope, and erosion as to suggest that these physical features were inconsequential as compared to soil texture and structure. As a follow-up, the current study will involve tests on what appear to be "high" and "low" infiltration strata within several of the common range types on the Woodtick Triplicate watersheds. The measurements are designed so as to test the hypothesis that soil is the dominant factor influencing infiltration as measured by the North Fork Infiltrometer.

Pacific Northwest

Effect of Forest Cover on Streamflow and Runoff. The Tillamook fire of August 1933 destroyed the forest cover over about 77 percent of the Wilson River and 81 percent of the Trask River watersheds above the respective gaging stations. Streamflow studies

were initiated on both of these rivers two years before the fire and records available for a 5-year period following the fire permit some interesting comparisons. Prior to 1933 no meteorological stations were located within either of these drainage basins. Hence, the mean precipitation for the three nearest stations (Seaside, Timber, and Forest Grove) was determined and these ratios were applied to the Trask and Wilson River watersheds. Thus, only relationships rather than exact quantities could be considered. It was found:

1. There is a very close correlation between total precipitation and total runoff.

2. When the watershed was forest covered the dry season flow was better sustained than after the watershed was burned over. Though the June to September rainfall after the fire was nearly 37 percent greater than before the fire, the summer discharge of the Wilson River was about 14 percent less and of the Trask River 8 percent less than before the fire.

3. The maximum daily runoff and the fluctuations in runoff were greater after the fire than before.

Much of the area devastated by the Tillamook fire was reburned this year and these studies will be continued to determine the effect of the 1939 fire.

Rocky Mountain

Snow evaporation experiments under way. Rounding out the program of research on snow on the Fraser Experimental Forest, a group of instruments is being set up for the study of evaporation and seepage flow from snow in place. The purposes of the study are to calibrate instruments for measurement of snow evaporation, and to provide some quantitative figures on water losses from snow in the Rocky Mountains.

The installation, to be completed this autumn, consists of one large circular surface, 500 square feet in area, surrounded by smaller instruments: one pair, each of which is 20 square feet in area, a pair of four-square-foot pans, and four pans one square foot in area. The largest surface is subdivided by an inner circle into two areas, 100 and 400 square feet in area. These and the 20-foot surface are in the form of shallow cones, covered with gravel, sand, and pine litter and draining to the center, where melt-water is carried off into collector cans in a concrete lined pit.

Snow depths will be read by eye at four graduated wands placed on the large surfaces; densities and water contents will be taken on eight sampling boards placed on the ground immediately around the largest surface.

The one- and four-square-foot instruments are shallow pans with a perforated false bottom and a rim of pyrolin to reduce insolation effects to a minimum. These pans, filled with a core of snow, will be buried in the snow column surrounding the large surfaces. Measurement of evaporation losses will be made by weight. To evaluate meteorological factors, a complete weather station will be maintained.

Eventually, if this type of installation appears to give satisfactory results from a technical aspect, the whole installation will be duplicated. It is hoped that a clibration of the small weighing instruments will be obtained, which may justify their extensive use for measuring snow evaporation under timber stands.

STABILIZATION OF SOILS

Appalachian

Roadbank Fixation

Although the report of seeding and fertilizing mulched road banks, carried out in the spring of 1939, is not yet available, some valuable general conclusions can be drawn.

Light mulchings of weed straw on relatively fertile banks in the Southern Appalachians have produced satisfactory bank stabilization through favoring the growth of natural vegetation, with no further fertilizing.

On infertile banks a light application of fertilizer, for example, 400 pounds of 4-8-4, has been found to encourage growth of natural vegetation.

Where the straw of small grain has been employed and natural seed lacking, successful cover has been obtained by light seeding during late spring months. Best results have been obtained when the seeding has been accompanied by light applications of fertilizer. Lespedeza sorica, common lespedeza, and Japan clover have proved most successful in the southern Appalachians. Of the grasses, redtop, herds-grass, and orchard-grass with light mixture of blue grass have been used effectively.

Because seedlings had to dry out during the summer, poor results have been obtained by seeding banks on which the mulch has been applied too thick and soil placed on the surface to hold the mulch in place.

Southwestern

Vegetation on steep mountain slopes. On August 5, a rain of cloudburst proportions and its effect on steep mountain slopes afforded an opportunity for evaluating (1) the tremendous potentialities for destructive erosion and (2) the marvelous control afforded by vegetation. The greatest amount and highest intensity of fall recorded on the Sierra Ancha Experimental Forest watershed, where this storm occurred, fell on some steep slope plots. These bordered plots are 35 feet in width and of two different lengths, constituting horizontal areas of 5,000 and 10,000 square feet. Each area has a small gully throughout its length. They have a slope inclination of 31 degrees, or 60 percent, and support a mixed grass and shrub cover. The soils are deep and rocky. The ground surface not occupied by vegetation is strewn with loose rock, the effect of former runoff conditions.

All plots were fenced against cattle in 1933 and equipped to measure runoff and eroded material. Precipitation is measured by standard and recording gages. Rate of surface runoff is recorded by large tipping buckets which empty into tanks where volume measurements are made.

The condition of the vegetation, particularly the grasses, has improved greatly and with the exception of two major storm periods — one in September 1933 and the storm of August 5, 1939 — runoff and erosion have been well controlled. Winter rains are naturally of low intensity, although the fall for this period usually amounts to about 15 inches, but summer storms are commonly of torrential character.

At the time of this year's heavy storm, some plots had been ungrazed for 6 years and two plots had been ungrazed for 4 years, and then grazed in the early summer of 1938. Grazing treatment on these two plots was also begun in the summer of 1939, but was discontinued when very little use was had because of an accident to the animal.

During the storm of August 5 a total of 5.61 inches of rain was recorded between 4 and 9 p.m., of which 5.02 inches fell in the first two hours and 15 minutes. The record by 5-minute intervals showed two periods of high intensity fall and nearly alike in duration and amount but separated by a 5-minute period with almost

no rain. Each period of high intensity of fall had almost 30 minutes in which the minimum intensity per 5 minutes was two-tenths of an inch and the maximum, thirty-eight hundredths of an inch.

All the details of what happened cannot be presented here, but it should suffice to show that the vegetation on ungrazed areas and parts of areas that were in good condition afforded almost complete protection, whereas the plots that were grazed after 4 years' exclusion were riddled by destructive runoff and erosion.

Of the two plots that are 5,000 square feet in area, the ungrazed delivered the equivalent of only .16 of an inch of runoff out of the 5.61 inches of rain water and only one-fourth cubic foot of silt, as compared with .79 of an inch of runoff and 19 cubic feet of silt and rocks from the grazed area. On the ungrazed area there was no noticeable effect of runoff, not even in the gully, whereas many new but small gullies were formed on the grazed area and probably more silt and rock in total was moved a short distance and left piled back of shrub and grass clumps on the plot than the 19 cubic feet delivered from it. Of this displaced material, the finer parts left may be expected to wash away with each new rain; even low intensity winter rains will move it.

The destruction on grazed areas and also parts of ungrazed areas with old but small sore spots was so great that undoubtedly many years will be required to repair the damage.

Outside the experimental areas but on the same slope and where grazing has continued each year, the damage was astounding. The ground surface was riddled with new gullies; mounds of debris were piled above and over shrub and grass clumps; mud and rock flows originated on old sore spots and pushed down the larger gullies, scouring them to much greater widths and depths; mud flows were higher than the lips of gullies 4 to 5 feet deep, as is shown by the piles of rocks left on the lips; and rocks several cubic feet in size were discharged from gullies draining areas no more than 3 to 6 acres in size.

This storm was a severe test, but the indications are that similar storms occur locally somewhere on the mountainous district concerned almost every summer. The test proved just what development of vegetation and soil in natural areas indicates, namely that such rains cause no more damage than is repaired over a long period of years provided the development of vegetation is not held in check by other destructive influences. It also showed that small spots, old depleted scars no larger than 30 feet in diameter, can be the source of runoff and mud flows that course downward through well-revegetated areas, opening old wounds, and spreading new destruction. Furthermore, the old sore spots were bared of topsoils, have revegetated very slowly, and new vegetation has been sparse and thin.

From time to time comparisons of runoff and erosion on the grazed and ungrazed plots will be reported.

RANGE RESEARCH

ARTIFICIAL REVEGETATION

Intermountain

Site Factors

Map and Seed Collections. In an effort to locate and define areas suitable or in need of artificial revegetation in the Intermountain Region, a map showing deteriorated range areas which cannot be revegetated naturally under proper stocking and management in the next 10 to 20 years, has been prepared. All available published material such as range report maps, critical area maps of the forests prepared by the Supervisors, and Planning Board Reports were used as sources, but much of the map was sketched in on the basis of knowledge of field conditions by members of the Experiment Station staff, Forest Supervisors, Rangers, and local residents. The map is admittedly approximate and doubtless contains numerous errors, but it presents the best available information in a concise form and is vastly superior to any body of knowledge previously available for planning the work of the Artificial Revegetation project.

A summary of planimetered areas is presented below.

Reseeding Types	Acres by States				
	Utah	Idaho	Nevada	Wyoming	Total
Deteriorated sage	5,873,000	5,417,000	17,857,000	4,931,000	34,078,000
Burned sage	--	2,048,000	--	--	2,048,000
Abandoned plowed land	1,437,000	2,593,000	12,000	--	4,042,000
Mountain brush	279,000	46,000	355,000	1,000	681,000
Aspen	116,000	--	23,000	--	139,000
Alpine	22,000	93,000	14,000	--	129,000
Total	7,737,000	10,197,000	18,261,000	4,932,000	41,117,000

In considering these figures it should be borne in mind that in the preparation of this map it was often impossible to separate the really critical areas from the larger and less seriously deteriorated fringes surrounding and intermixed with them. Although the total acreage of "sore spots" and of the surrounding fringes and interspersed tracts that are not permanently damaged is probably somewhere near the figure indicated, the acreage actually to be reseeded and on which an effective artificial revegetation program will have to be planned is much smaller than that shown. It will take a more comprehensive and more detailed analysis than it has yet been possible to make in order to arrive at a moderately close estimate of the acreage that will not revegetate naturally, if and when reasonable protection can be provided.

Seed Supply. To provide easily available seed supplies of those desirable species which either disseminate quickly after ripening, or grow in scattered or isolated stands and are therefore difficult to collect in the field, row plantings of 28 species have been made at the Logan nursery, spaced at 3-foot intervals. They will be irrigated in order to produce maximum yields.

It is highly significant to note the recent reductions in price of seed of many grasses which are being used extensively in range reseeding. The high cost of seed has been one of the major difficulties in executing reseeding programs at reasonable costs, but studies have shown that seed of most native species can be produced under cultivation, and growers have indicated that they will supply seed of species for which there is a real demand at prices less than 25 cents per pound. Following are comparative quoted prices of seed of four species of grasses in 1936 and 1939:

Species	Price per pound	
	1936	1939
Agropyron cristatum (crested wheatgrass)	$ .58	$ .165
Agropyron spicatum 1/ (bluebunch wheatgrass)	.70	.50
Bromus carinatus 2/ (mountain brome)	.30	.15
Poa bulbosa 3/ (bulbous bluegrass)	.20	.10

1/ Collected on native range, 1936, 1939.
2/ Collected on native range in limited amounts by sheep herders, 1936; grown under cultivation 1939.
3/ Purchased in 1938 @ 5 cents.

In recognition of the potential importance of native plants in artificial revegetation, a vigorous program of seed collection has been conducted during the past field season. Seeds of 202 important range-watershed species have been collected in spite of an exceptionally poor seed year throughout the region. These include one hundred and two species of grasses, 60 weeds, including 44 legumes, and 40 shrubs. Since little is known regarding the germination requirements and reseeding adaptations of many species only a pound or less of each, enough to make preliminary trials, was collected. Some species have already demonstrated their value on small plots and enough of these have been collected to make larger plantings.

Two simple collecting devices were used in this program. The most adaptable of these consists of two paddles provided with handles (screen door pulls) on the back and corrugated rubber matting on the face. The heads of seed are held over a shallow iron-rimmed canvas bag slung from the operator's shoulders and rubbed between the paddles to gather the seed. This simple device is much more effective than hand gathering.

The other device employs a light reel provided with a crank handle and six paddles. The reel is revolved against the ripened seed heads and the seed is thrown into a pouch mounted behind the reel. The entire unit is suspended from the collector's shoulders. This device is highly efficient in pure stands growing about waist high, under which conditions rapid collection can be attained.

Northern Rocky Mountain

The dry period of April and May proved to be a real handicap to reseeded areas at Miles City. However, good stands were obtained from seeding in the fall of 1938 and this spring of most grass species of Missoula and Vigilante nurseries. Most of several legumes tried appear to do better from spring seeding but few failures occurred when they were seeded in the fall. Fall seeding of mixtures containing a legume is thus still in the picture. Several comparatively recent introductions, especially in the Agropyron group, have made a very good showing. This is also true of a few others, including Lotus seed from New York state.

GRAZING MANAGEMENT

California

Field work at the Blacks Mountain Branch during the last 4 months has been centered chiefly on phenological observations, cattle weights, and other pointed observations, to round out material for a 3-year progress report and for outlining the course of future work.

Phenology. Checks this year have verified an observation of the past 3 years that there is considerable difference in the date of range readiness of adjoining meadow and timber types. In the spring the timbered south slopes are warmer than the meadows and plant growth is usually earlier there; also the soils are dry enough to withstand trampling earlier than the wetter meadow soils. Probably the timber could be grazed two weeks or more before the meadows in the average year. The year 1939 was a drouth year, and water and snow did not stay on the meadows during the spring as is normally the case, so there was no decided difference in the early-season range condition between the two types; soils in both were dry before the plants were ready to graze. Moreover, both types were ready to graze about a month ahead of previous average dates.

This year's records, taken periodically on 222 plants in 6 sites -- 3 in timber, 1 in sage, and 2 in meadow -- point out the extreme variation in date of range readiness that may follow a winter of light precipitation. During the past dry season only about 8 inches of precipitation were recorded at Halls Flat. This is about 1/2 of average. As a result, growth was much lighter in all types and only a few range-plant species produced seed. Growth was retarded more on meadows than on the upland timber and browse types. Ordinarily moist until mid-June, most meadows were dry in early April. Apparently meadows bear an even greater grazing load -- closer utilization -- during drought years than in average or better-than-average years.

Response of cattle to forage. Indications of the nutritive value of the forage and of the dates when the grazing season should be started and ended have been furnished by animal weights from the Burgess Spring pasture, stocked with cattle since 1936.

The beginning of the grazing season is judged first by the condition of the forage, whereas the end is judged both by the condition of the forage and by the condition of the livestock. It is possible that livestock may suffer loss in weight before the forage is completely utilized, in which case the livestock may be considered first in judging the duration of the grazing season.

Each year from 1936 to 1938 the livestock stopped gaining in weight during the latter part of September -- in 1936 on approximately September 15, in 1937 about September 27, and in 1938 again about September 15. In 1938 utilization was very close and it could not be determined whether the quality of the feed or its shortage caused the drop in livestock gains. In contrast, considerable forage was left on the ground at the end of the grazing season in 1936 and 1937, and it appeared that a loss in nutritive value of the forage declines rapidly after the forage dries up and livestock also slow down in the rate of gain in weight and finally stop when most of the forage is dry.

This year the cattle were in the pasture only 6 weeks. They entered on August 10 and were taken out on September 21. An abundance of forage remained on the ground after this short grazing season. With this large supply of forage the livestock had full selection of the forage species. Practically 60 percent of the forage was dry on August 10 when the cattle entered the pasture. On September 21 when they left, approximately 90 percent of the feed was dry. Consequently, the cattle subsisted to a great extent on dry feed. Four weighings were made during the period. Average weights for the 14 head of steers and dry cows are given in the following table.

Cattle Weights
Burgess Spring Experimental Range, 1939

Date	Aug. 10	Aug. 24	Sept. 7	Sept. 21
Weight	1,064	1,053	1,080	1,057

The figures show an actual loss of 7 pounds per head. It is difficult to obtain strictly comparable weights and this figure is too small to be significant. Apparently the stock just about maintained their weight while in the pasture. It is evident that they failed to make material gains in spite of an abundance of feed. Close watch on the cattle seemed to indicate that they reached a peak weight about September 7, at least a week earlier than in 1936 and 1938 and approximately 2 weeks earlier than in 1937. The phenological records for these years seem to follow the same general trend. This seems to indicate clearly that certain feed deficiencies develop in the forage following plant maturity, which entails either removal of livestock from the range or supplementing the range forage with the lacking essentials -- if a late-season fall in weight is to be prevented.

It was unfortunate that the livestock could not be kept on the pasture for another month or so to establish definitely the weight trend toward the end of a later-than-usual grazing season. This is

the next needed step in the study -- although a difficult one to work out with permitted stock whose owners do not like to leave the animals on the mountain range after they have started to lose weight rapidly.

Central States

Late in September, Chapline from Washington, Wilson and Hill from Milwaukee, Diehl and Hornkohl from the Mark Twain, Turney from the Clark, Hammer and Silkett from Columbia, Mo., Hall, Day and Liming from the Station, devoted three days to a field appraisal of the important range problems in the Missouri Ozarks with the view toward determining early needs for range research. The magnitude of the range problems, especially in southwestern Missouri, and their economic and sociologic bearing on the National Forest program in the Ozarks had not been thoroughly appreciated before. Unquestionably, range research is of high priority in this section.

Intermountain

Drought Again Pinches Utah Stockmen. Drought conditions on many of the high summer ranges in central Utah have been severe during the past summer. Forage was far below average in production and inferior in quality. Plants matured early and by the latter part of June much of the vegetation, particularly the weeds, had dried prematurely. Livestock became restless and ate the dry forage poorly, and as a result much of the feed was trampled. Although grazing has been restricted, ranges were so closely utilized that livestock were forced to leave many of the summer ranges 10 to 15 days earlier than usual.

Precipitation, normal until about March 1, was extremely deficient during the spring growing season, June and July receiving almost no rainfall. High temperature during this latter period increased the drying of the forage and left it rather unpalatable to livestock.

Forage production on the summer ranges of the Intermountain Region in general, show serious effects of drought. On some of the areas most severely affected, forage production has been estimated to be as much as 50 percent below other years. On the other hand, in a few areas particularly in Nevada, summer storms brought seasonal precipitation nearly up to normal, and most of the Nevada ranges are in good condition.

Because of the drought and poor forage conditions, lambs leaving the summer ranges are somewhat lighter than last season, as a whole reaching market from 5 to 10 pounds lighter than last

year with 10 to 20 percent more of them in the feeder class. From herds which were weighed last year and this year, lambs now average 7 pounds lighter. Mature ewes in the most herds are in fair condition although in general they are approximately 7 to 10 pounds lighter than a year ago. In a few of the most choice range areas, ewes are in about the same flesh as a year ago and the lambs only slightly lighter. On the whole, ewes on national forest range fared well until the forage became dry during July, after which date, livestock apparently lost weight owing to the fact that the forage crop was low and the quality of the herbage inferior to green mature vegetation.

Winter ranges in Utah also suffered from drought. As shown by the forage records at the Desert Range Branch Station there is a decrease in density of 10 to 35 percent and a reduction in herbage production of from 30 to 60 percent as compared with last year. Good stands of vigorous native vegetation show an average decrease in forage production of approximately 30 percent, while on ranges which have been subjected to heavy grazing and on which Russian-thistle is abundant have herbage production that is from 50 to 70 percent below that of last year.

Russian-thistle is a serious hazard to the stockmen who use it as a basis of annual forage because of the great variability in production from year to year. Though in years of abundant moisture it grows luxuriantly, during periods of summer drought it grows sparsely and seldom exceeds two to three inches in height. The variation in forage production on ranges overrun with this exotic annual is two to three times greater than on similar areas supporting native plants. For example an area in Wah Wah Valley in 1937 produced 365 pounds of herbage, of which 261 pounds was Russian-thistle. This year the same area produced approximately 134 pounds per acre of which only 67 pounds was Russian-thistle. Milford Bench in 1937 produced 1,046 pounds of Russian-thistle per acre, whereas this season its yield was less than 140 pounds, or only about 13 percent of that in 1937.

Stockmen are justifiably much concerned over the prospects of a shortage of forage on the winter ranges this year. Many operators have made provisions to feed hay in feed lots or to provide concentrates of corn or cottonseed cake. With sheep leaving the summer range 7 to 10 pounds lighter, and therefore weaker, and with a short supply of forage on the winter ranges, the prospects for heavy death losses are very great. Favorable fall rains, now due, would greatly mitigate the difficulty and reduce the hazard by bringing about considerable growth of desert plants during October.

Summer Range

Checking Estimates of Average Height of Bunchgrasses. In range management studies, especially those relating to phenology, height of grass is commonly accepted as one measure of development. Maximum height, in contrast with average height, is easy to measure; but it has the disadvantages of being subject to wide fluctuations, and giving, in cold figures, only an extreme picture of the vegetation. Average height is a more generally useful concept, but its estimation is subject to varying degrees of personal error, or bias. In an attempt to correct or standardize some of this personal error in fairly well experienced field observers at the Great Basin Branch Station, a check test was performed.

Fifteen plants of Bromus carinatus and 25 plants of Stipa lettermani were staked. The maximum height was measured and the average height estimated on each plant by five independent observers. Then five of the 15 Bromus and 15 of the 25 Stipa plants were clipped at ground level and brought into the laboratory. The leaves were counted and measured, thus obtaining a "true" average height for each plant. The observers compared their estimates with these true average values, and then, presumably with a revised concept of average height, went into the field and again estimated the remaining 10 plants of each species. This done, five plants of each species were brought into the laboratory as before, and measured in detail. Then, with this second correction in mind, the observers estimated the last five plants of each species, and finally cut and measured them.

By this procedure it was hoped that a progressive adjustment would take place in each man's conception of average height. Two incidental points should be noted. First the Bromus plants were reasonably typical as to leafage, but the Stipa plants had an abnormally few, long leaves. Hence a correction based on such Stipa plants may not be the same as one based on more normal specimens. Second, the observers were probably not much influenced, in their later estimates of a plant, by their earlier estimates; at least, they themselves disclaimed remembering earlier estimates.

As shown in the table, most of the first estimates were much too great. Those for Bromus averaged 4.3 cm per plant too high. On the first trial, three of the five observers estimated the average of Stipa too liberally, and one too conservatively. The fifth observer's deviation was within the accepted range of random error.

In general, the second and third trials were more conservative, and showed a marked improvement over the first. There was slight, if any, improvement in the third over the second trial.

It is interesting to note evidences of self-consciousness of some observers during this process of adjustment. Thus Observer D was just as badly biased on the low side in the last trial as he was on the high side in the first! This would indicate that for Observer D, at least, and probably for some others, further standardization was necessary.

There is no reason to believe that the effects of standardization are permanent. It seems likely from fluctuations in plant-height records, that check trials of this sort may be necessary at frequent intervals throughout the field season.

Average deviations of observers' measurements from true average grass heights, in cm., and probabilities of occurrence of such deviations by chance.

Observer	A			B			C			D			E		
Trial	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
							Bromus carinatus								
Av. dev.	+6.30	+0.31	+0.21	+5.38	+0.51	+0.41	+4.30	-0.39	-1.69	+3.17	+0.11	-2.09	+2.37	+1.21	+1.11
P	<.01	.68	.43	<.01	.33	.73	<.01	.42	.06	<.01	.88	<.01	<.01	.13	.23
							Stipa lettermani								
Av. dev.	+3.59	-1.43	+0.24	+1.11	+0.17	+0.44	+0.19	+1.47	-0.96	+1.23	+1.17	-1.96	-1.37	+0.67	-0.96
P	<.01	<.01	.54	<.01	.56	.45	.58	<.01	.21	.01	.01	<.01	<.01	.12	.14

Spring-Fall Ranges

Herbage Moisture Content. Records of herbage moisture content are an integral part of forage inventories conducted by the weight-estimate-method. It is necessary to convert estimates of green herbage weight to dry weight in order to permit unbiased comparisons of forage production between years and between different periods of the same year.

It has been the procedure in the use of the weight-estimate-method to retain the herbage clipped from check plots and plots used in training, and to air dry the herbage and use these data for determining the moisture content at each date on which an inventory was made. At least five samples of herbage have been taken for each of the more important plant species at each date.

Analysis of these data for 1937 and 1938 together with the available records of seasonal herbage production for the period, 1936 to 1939 inclusive, and records of variation in moisture content of herbage from a 1/2-acre area harvested in 1938 have been used to provide some indication of variations in moisture content and the adequacy of sampling provided by the present system. Data from bluebunch wheatgrass (Agropyron spicatum), arrowleaf balsamroot (Balsamorhiza sagittata), and threetip sagebrush (Artemisia tripatita) were used as examples of variations in grasses, weeds and shrubs.

Table 1. Herbage moisture content during the growing season, 1938.

Date	Bluebunch wheatgrass	Arrowleaf balsamroot	Threetip sagebrush
May 10	65	83	62
" 11	--	81	61
" 16	59	80	70
" 24	57	81	67
" 26	61	78	65
" 27	64	79	68
" 30	57	81	63
June 13	49	71	63
" 14	46	63	57
" 28	46	61	57
" 29	42	52	56
" 30	53	64	62
July 1	52	65	59
" 6	46	68	62
" 14	40	60	52
" 15	39	61	54

With the two herbaceous species, bluebunch wheatgras and arrowleaf balsamroot, the definite downward trend in moisture content with the progress of the growing season is somewhat obscured by the fact that at each date samples were drawn from a nearby, but different area. Periods of heavy precipitation, notably at the last of June, interrupted the downward march of moisture content. With threetip sagebrush there does not appear to be any noticeable trend in moisture content.

In addition to growth stage, available supply of soil moisture, site, and plant species which may affect the herbage moisture content, there may be many others not discernible in the available data. In any event, it would seem likely that samples should be drawn for each species of importance at the date and upon the area being inventoried.

Some information concerning the number and size of samples to be drawn may be obtained from data summarized in table 2.

Table 2. Summary of herbage-moisture-content sampling errors when five samples are drawn from an area.

Species	Year	Size area samples	Duration of harvest	Aver. green wt. sample	Sampling error
		acres	days	grams	percent
Bluebunch wheatgrass	1937	80	1	140	2.8
	1938	80	1	130	2.3
	1936-1939	80	1	80	2.0
	1938	1/2	10	125	3.1
Arrowleaf balsamroot	1937	80	1	260	1.9
	1938	80	1	240	2.1
	1936-1939	80	1	480	1.5
	1938	1/2	10	230	2.9
Threetip sagebrush	1937	80	1	100	2.1
	1938	80	1	100	2.7

When relatively uniform areas of the sagebrush-grass type of less than 80 acres in size are being sampled the present intensity being used provides an estimate of the average herbage moisture content for a single species with a sampling error of less than 5 percent. Thus herbage collected from the five check plots used each

day to secure an estimate of the personal bias will suffice in providing a reliable record of herbage moisture content for the more important plant species. Samples should, however, be collected each day that an inventory is being made, upon the area studied. Records of herbage moisture content for one plant species should be used for another only after it is established that the trends of the two species are alike. Although no data are at hand on the size of sample it is likely that samples should be fairly large, i.e., at least 100 grams.

Northern Rocky Mountain

Short Grass Ranges. Eastern Montana narrowly missed another severe drought that did strike much of eastern Wyoming this year. Cattle were held on our winter pastures two weeks later than normal because there was little or no forage growth on summer pastures on May 15. Rains started about May 25 causing grama grasses and some others to make a splendid height growth in June. Also, the density of grama increased substantially toward the 1933 level. A dry April and May, however, appeared to reduce severely the density of Sandberg bluegrass.

The plan of using one mature bull for 60 cows in six pastures instead of one yearling for each pasture which has been urged for several years was tried out this year at Miles City with unsatisfactory results. The breeding season was extended from the normal of about 45 days in the past to 66 days this year and additional bulls used the last 10 days. Even if the calf crop is normal in 1940, this extension of 3 weeks is objectionable because it will doubtless increase variability in weights, due to age.

Pacific Northwest

Summer Range

The range survey methods crew finished field work September 15, on schedule, and is now tackling the job of summarizing the data.

Utilization surveys were made of the Starkey cattle allotment on the Umatilla Forest to determine forage preference, utilization pattern, and distribution problems on a timbered range typical of the Blue Mountain country. The Starkey allotment has been selected as a study area on which efforts will be made to determine the effect of rotation of grazing and improved management in rehabilitating soil and vegetation on timbered cattle ranges and in balancing use between timbered and open range types. Definite plans for experimental design and for needed physical improvements will be made

this winter in order that the project may be initiated in the spring of 1940.

A State WPA project has almost completed a tabular summary of the 1937 AAA range surveys in the State of Oregon that will be made available in mimeograph form when completed. WPA has also computed forage factors on 39,000 AAA plots representing a yet undetermined number of subtypes in 15 of the 18 standard range survey types to arrive at a statistical expression of forage variability of subtypes and a guide to sampling intensities required for range surveys of them.

Rocky Mountain

Utilization of important plants by sheep on summer range infested with orange sneezeweed. The grazing habits, movements, and management practices of two bands of sheep were observed and measured day by day throughout most of the summer of 1939 on the Uncompahgre National Forest. The allotments studied have fairly heavy infestations of orange sneezeweed (Helenium hoopesii) and the herds grazing them have suffered severe losses for several years. Among the items observed was the utilization percentage by weight of orange sneezeweed and other associated plants considered important because of abundance or degree of use.

In general, the method used to obtain utilization percentages was to clip and weigh a number of plant units of a given species before grazing a certain area and then repeat the process on the same number of plant units after grazing. The difference in weights before and after grazing was expressed in percent. A plant unit consisted of a single leaf, a single plant, one half of a plant clump or 1/16 of a foot of ground cover, depending on growth form. In securing samples for weighing all plants were clipped one-half inch above ground. Ordinarily only one to three days elapsed between the samples taken before and after grazing.

Each sample consisted of from 10 to 1000 plant units. This varied between species but was usually constant within a species. The composite sample was made up of usually 10 weighings of from 1 to 100 plant units selected at equally spaced intervals along strips located to intercept the area grazed. After grazing the same number of plant units along the strip were clipped and weighed. The analysis of the data obtained is not finished but pending completion the results in the following table are of interest. The degree of use as indicated in the table is an average for the entire 1939 season. In considering this average, however, two factors should be kept in mind. First, the allotment was grazed too heavily; and, second, lack of water prevented uniform use.

Summary of Utilization Data on Allotment Grazed by Bond No. 1 (Poorly Managed)

Species	Utilization Data				Assigned Palatability 2/	Average percent Utilized
	Description of a unit	Units weighed before grazing 1/ Each sample	Total	Areas sampled		
Helenium hoopesii:						
Rosette plants	1 nonflowering plant	50 or 100	1200	13		60.0
Flower stalks	1 entire flower stalk	10	360	36	10	42.6
Flower heads	1 flower head 3/	21 to 150	1367	33		93.7
Carex sp.	1 cluster of blades	1000	8000	8	30	31.0
Thermopsis montana	1 single stem plant	100	600	6	0	37.3
Lathyrus leucanthus	1 single stem plant	100 to 250	1100	9	80	28.1
Festuca thurberi	1 clump or 1/2 clump 4/	5 or 10	94	8	20	26.3
Frasera speciosa	1 plant or 1 leaf	10 to 60	161	4	30	43.7
Delphinium subalpinum	1 plant	10 to 75	141	4	80	34.5
Achillea lanulosa	1 flowerstalk, complete	100	300	3	50	37.4
Leontodon taraxacum	1 plant	100	400	4	80	83.0
Bromus carinatus	1 single stem	250	250	1	60	23.9
Bromus anomalus	1 single stem	200	200	1	50	60.0
Agropyron pauciflorum 5/	1 single stem	250	500	2	60	32.9
Stipa lettermani	1/16 sq.ft. basal area	18 1/2	18 1/2	1	40	26.3
Stipa columbiana	1 stem	250	250	1	40	8.6
Pseudocymopterus sp.	1 stem	100	300	3	80	63.3
Lupinus sp.	1 stem	36	72	2	40	63.6
Erigeron subtrinervis	1 stem	100	200	2	30	65.8
Wyethia sp.	1 leaf	360	360	1	10	49.3
Chrysopsis villosa	1 stem	250 or 500	750	2	10	40.7
Senecio serra	1 plant	36	36	1	30	41.2
Symphoricarpus sp.	1 current twig	250 or 500	2750	6	40	46.5
Populus tremuloides	1 current twig	100	100	1	0	59.2

1/ The same number of units were weighed after grazing.
2/ Palatability for sheep as given in palatability table for Colorado and Wyoming range plants.
3/ The number of grazed and ungrazed flower heads were counted but not weighed.
4/ One-half of a clump of grass was clipped before grazing and the other half after grazing.
5/ Includes agropyron pauciflorum and A. subsecundum.

Several species are of particular interest. About 55 to 60 percent utilization of orange sneezeweed checks closely with empirical observations. This species was grazed closely wherever it occurred. The sheep would normally graze the heads first, the stem leaves next, and the basal leaves last.

Carex, Symphoricarpus, Festuca thurberi, Lathyrus leucanthus, and Thermopsis montana were the most abundant plants. Considering abundance and degree of use, the following, arranged in order, were the most important forage species for sheep: Symphoricarpus, Carex, Leontodon taraxacum, Lathyrus leucanthus, Festuca thurberi, and Thermopsis montana. Thermopsis is ordinarily considered a very poor forage plant but observations during the 1939 season indicate differently.

Yarrow (Archillea lanulosa) is generally regarded as having moderately high palatability. The utilization of 37.4 percent was based on flowerstalks only, because throughout the season only in rare instances were sheep noted grazing the basal or rosette leaves. If these observations are borne out by further checks, the proper use factor for yarrow should be lowered considerably.

Pseudocymopterus sp., Leontodon taraxacum, Delphinium subalpinum, and Senecio serra might be called "Cocktail" plants because they were grazed first when sheep entered a new area.

The experience and information gained during 1939 indicates that much pertinent, basic information on utilization, management, economics, and other phases of range management research can be obtained by actual allotment-use studies.

Southwestern

Arizona rainfall and range conditions. In southwestern Arizona 1939 started out with what appeared to be better than average prospects for a good year insofar as range conditions were concerned. Fairly general precipitation during December, 1938, and January and February, 1939, started a very heavy crop of spring annuals in nearly all sections. However, continued low temperatures through March prevented any really good growth while moisture conditions were favorable; by the time temperatures were high enough to stimulate growth the moisture was gone, with the result that the spring annual crop dried up and was largely a failure. The spring dry period was somewhat more severe than usual lasting, over most of the section covered, from March until late in July. Following this, the summer rains, except for certain sections, were not only very scattered but of a periodic nature with rather long intervening dry periods. A strip, 15 to 20 miles in width extending along the Mexican border from the Baboquivari

Mountains to southwestern New Mexico, received fairly continuous rains, and forage conditions are better there than they have been at any time during the past 4 or 5 years. A few other spots in the vicinity of Globe, Benson, Duncan, and Willcox received fairly good rains and produced a fair crop of forage. Over the remaining portion of southeastern Arizona rain was definitely inadequate and the forage crop below average.

Throughout the section and even where the current summer's growth was good stockmen were inclined to comment that the stand of grass was very light. General observations, as well as the opinion of stockmen, would indicate that the stand of perennial grasses, even where rainfall was good, amounted to little better than half what it was 4 or 5 years ago. In the drier sections loss in stand is even greater. Desert ranges near Phoenix benefited greatly by late September rains and are reported in excellent shape.

Range water. As early as the latter part of May the range water situation in many localities began to be serious. Surface tanks and many springs were dry, while many apparently permanent wells and springs were very weak and failed to furnish sufficient water for cattle dependent on them. As a result of this condition well drillers were at a premium. Stockmen everywhere were drilling and equipping new wells in order to provide water for their cattle. A great many surface tanks were also constructed throughout the section. In a few instances cattlemen had to haul water for their cattle in tank wagons.

Condition of cattle. At the beginning of spring most cattle were in approximately normal condition for that season of the year; however, with the failure of spring feed they continued to shrink until summer rains started. In some places cows with calves have remained considerably below average throughout the summer. Calves born under these conditions got off to a poor start and will probably average fifty to seventy-five pounds lighter than usual.

Some supplemental feed was necessary on grass ranges in June and the early part of July. The Diamond A outfit, in southwestern New Mexico, had some 2500 head of cows on feed early in July and were trucking alfalfa and cake from El Paso and Phoenix.

Marketing. The movement of cattle to market promises to be heavy this fall, largely because of shortage of range feed. Some early contracts were made for steer calves at 9 cents a pound for November delivery. The majority of buyers have held off until recently and most of the present contracts are around 7 cents to 7-1/2 cents for heifer calves and around 7-1/2 cents to 8 cents for steer calves. Weights of calves delivered early in November will probably average around 280 pounds. Many cattlemen throughout the southeastern part of the State are culling their breeding herds heavily this fall,

and in addition selling all their calves in an effort to get through the winter without the expense of feeding. Cows are selling at around $40 a head.

Noxious Plant Control

Snakeweed. The methods of eradication used were those which appeared most promising or at present are in use by stockmen and consisted of burning (with a flame gun, since there was not sufficient inflammable material present to broadcast burn), grubbing, and spraying with a 15-percent aqueous solution of sodium chlorate. The treatments are compared as to effectiveness and cost in table 1.

On these large plots grubbing was found to be cheapest and most practical. However, in other situations as on extremely rocky soils or in brushy areas, burning or sodium chlorate sprays may be better adapted.

Table 1.--Comparison of treatments as to effectiveness and cost as applied to dense stands of snakeweed (3,000 to 5,000 plants per acre).

Treatment	Number of .1 acre plots on which data is based	Percent of plants killed	Time required per acre	Amount of chemical per acre	Total cost per acre*
None (check)	24	13	-	-	-
Burning	24	85	9-3/4 hr.	10.1 gal. of Kerosene	3.94
15% Sodium chlorate	24	91	6¼ hrs.	59 lbs. of Sodium chlorate	7.46
Grubbing	24	87	6½ hrs.	None	1.63

*Labor plus chemical. Labor at 25 center per hour (prevailing wage in New Mexico for unskilled labor); Kerosene at 15 cents per gallon; sodium chlorate at 10 cents per pound.

It is perhaps too soon to draw definite conclusions as to what the effect on the grasses will be by eliminating snakeweed competition through eradication measures; however, the data presented in table 2 are of interest. In the case of plots which were grubbed there was a 196-percent increase in perennial grass above the natural increase on untreated plots. In the case of burning, the increase in grass was 54 percent and for plots treated with chlorates 14 percent increase for the first year following treatment. Preliminary analaysis of the data showed the latter increase

on burning and chlorate-treated plots as not to be significantly greater than on untreated plots.

Table 2.--Effect of treatments on perennial grass cover.

Treatment	No. of .1 acre plots	Grass density* 1938	Grass density* 1939	Increase	Percent Increase over check plots
None (check)	24	3.79	5.78	1.99	--
Burning	24	3.29	6.34	3.05	53.7
15% Sodium chlorate	24	3.45	5.64	2.19	14.1
Grubbing	24	3.87	9.77	5.90	195.9

*Grass density - lineal feet of perennial grass as measured on 528 feet of line transect per plot.

COOPERATING BUREAU PROJECTS

ENTOMOLOGY
(In cooperation with the Bureau of Entomology and Plant Quarantine)

Appalachian

A test of termite shields of various types was begun in a heavily populated "termitarium" at the Bent Creek Experimental Forest.

Examinations of test hickory sections infested with Lyctus powder post beetles indicate a definite relationship between starch content and insect damage. There is also an apparent relationship between insect damage and season of the year the timbers are felled, possibly a starch content-insect damage relationship.

Promising results were forthcoming from test injections of chemicals into trees in an effort to control destructive insects without materially injuring the tree.

The southern pine beetle has been very aggressive this year in the mountains and in parts of the Piedmont section of the Southeast, apparently as a result of deficiency in rainfall. Sprays for the control of this pest were investigated.

Central States

Severe damage to the oak stands by the 17 year locust has been noted by several staff members over an unusually extended area adjacent to Lake Michigan. In places east of Valparaiso Kellogg reports the leaves of the stands were more browned than green, from drying of twigs and leaves damaged by the process of oviposition. Black oak, jack oak, and other species on sandy soils were all attacked.

Lake States

The outbreak of spruce budworm on jack pine, coupled with an attack of the LeConte sawfly, which was first noticed on the Cut Foot Experimental Forest last year, is now assuming serious proportions, with defoliation amounting to 10 to 15 percent of the stand.

The Station plans to conduct salvage and control cutting operations this fall in cooperation with the Chippewa National Forest and the Bureau of Entomology and Plant Quarantine, in the hope that the forests can be put in better shape to withstand the attacks of this insect, for prevention rather than direct control is the best method of handling this problem. Dr. Graham has shown that the control of this insect in Michigan "depends upon maintainance of dense stands by close planting, filling in undesirable openings, removing susceptible trees in the course of liberation cuttings and thinnings, and the logging of jack pine stands before they become overmature."

Northeastern

T. J. Parr, of the New Haven, Conn., laboratory, reports as follows on the eastern spruce bark beetle situation in New England: "In a survey of mature and over-mature spruce stands in blow-down and other areas in the White and Green Mountain National Forests in New Hampshire and Vermont conducted during the first two weeks of August, it was found that the eastern spruce bark beetle (Dendroctonus piceaperda Hopk.) is still on the decline. In some areas in the White Mountains where there were light infestations last year, no insects were found this season. In "The Bowl", a primitive area near Wonalancet, New Hampshire, which apparently was rather heavily infested last year, fewer wind-thrown trees were infested this season than was the case in standing timber in 1938. A permanent sample strip 180 chains long and 3 chains wide in the Green Mountain National Forest had many trees infested in 1937, 8 infested trees in 1938, and but 2 trees infested this year, both of which were wind-thrown. No control measures have been recommended for the White Mountain or Green Mountain National Forest areas this year.

Southern

Bark beetles. An epidemic by Ips and the southern pine beetle on 6,000 acres of privately owned lands in southeast Jasper County, Texas was under 95 percent control early in August. Twenty-four million board feet of mature loblolly pine has been killed, of which 16 million board feet will be salvaged.

Lack of rainfall during the growing season, in some instances, complicated by fire scorching the trunks, led to killing of the tops of the weakened trees by Ips and later attack by the southern pine beetle and the breeding up of large numbers of bark beetles from an endemic to an epidemic status.

Control, suggested by this office in cooperation with the Texas Forest Service in May 1939, consisted in selective logging of the infested and susceptible trees within a quarter mile radius of active centers of infestation. At the height of operations in June and July, 70 trucks hauled 300,000 feet of timber per day to three mills within a 25-mile radius of the infested area.

Inspections in July of other infestations of pine timber by Ips near Bogalusa, La. and Gulfport, Miss. revealed endemic conditions. An area of 40 acres of small slash pine near Gulfport was heavily infested by Ips following a fire in May. This area had not been burned in 19 years and in consequence the dense cover of pine needles together with the heavy undergrowth resulted in a hot fire which killed approximately 50 percent of the trees outright. Almost all of the trees were severely scorched to within a few feet of the crown. The infested trees were cut and disposed of immediately.

Termites. Thirty-five termite-infested buildings treated by this Bureau2/ with 12 different soil poisons, 50 termite-infested buildings treated with 9 different soil poisons by commercial companies, and 20 buildings treated with 7 different soil poisons by the owners are under test at New Orleans. After one year's service, on July 1, 1939, the conclusions from these soil poison tests for buildings are that soil poisons are a valuable adjunct to structural methods of control, but unless the structural modifications are made, soil poisons are of little value in controlling termites.

On the Harrison Experimental Forest, a termite pit has been constructed and a series of experiments with various types of metal termite shields has been installed with the object of discovering the factors which determine the effectiveness of these metal barriers.

2/ Southern Forestry Notes, No. 28, New Orleans, July 1939.

On September 8, Snyder inspected the installation of metal termite shields on F.H.A. constructed buildings at New Orleans. A copper-coated, 26-gage galvanized iron, "bread pan" type of shield is installed for 20 cents per linear foot.

Powder-post beetles. Tests in cooperation with the lumber industry over a period of approximately three years, at Vicksburg, Miss., and Tallulah, La., have shown that green lumber dipped in a borax solution, 5-percent by weight (22 pounds borax in 50 gallons of water), for 10 seconds will in general prevent attack by Lyctus beetles.3/ At Tallulah, La., there are 125,000 feet of hardwood lumber dipped in this solution on the yard of the Chicago Mill and Lumber Company. Up to the first part of August, this has been exposed to attack for over 60 days without any infestation; the cost is approximately 25 cents a thousand feet. In the laboratory this dip has not given 100 percent protection, but there has been very little attack and possibly complete portection is too much to expect of any chemical.

Experiments over a 3-year period also indicate that a 10-second dip of one ounce sodium dinitrocyclohexylphenate to one gallon of water will protect green lumber from Lyctus attack; the cost, however, is 53 cents per thousand feet.

Laboratory experiments indicate that dipping dry lumber for 5 minutes in a solution of 5 percent pentachlorophenol and 95 percent fuel oil will kill all Lyctus beetles in logs and lumber; this will cost about a dollar per thousand feet.

Experiments are also under way with over 178 other chemical dips to determine whether lower percentages of the effective chemicals will suffice and whether there are cheaper, more effective protective chemicals.

Studies of the life history of the Lyctus beetles, their moisture and starch requirements are also under way. Both of the Lyctus species involved can complete their life cycle in a little over three months. One species of Lyctus can attack lumber with as high as 25 percent moisture, whereas previous experiments with another species indicated 15 percent was the maximum moisture content for attack. It would appear that the amount of starch content, age of wood and temperature are factors that determine the length of the life cycle of Lyctus beetles.

The most effective control against bostrichid powder-post beetles is to spray with 15 percent diphenyl, 15 percent trichlorobenzene, and 70 percent kerosene by weight at a cost of approximately 50 cents per thousand feet.

3/ Southern Lumberman, p. 34, Nashville, Tenn., Aug. 1, 1939.

Ambrosia Beetles. Christian at Tallulah has found the most effective method for combating ambrosia beetles is end-racking lumber for rapid drying. Experiments are being conducted with chemical sprays to prevent attack in the green log; dichloridphenyloxide, monochlor-diphenyloxide and p-tert-butyl-phenoxy-ethanol appear effective.

At Saucier, Mississippi, an insectary has been constructed on the Harrison Experimental Forest for the study of the biology and chemical control of ambrosia beetles and their cultivation of fungi. The experiments are being conducted by Johnston in cooperation with Doctor Verrall of the Bureau of Plant Industry, who has already made many hundred cultures of the fungi (See report for Pathology.) Xyleborus affinus Eichh. completes its life cycle in 7 weeks.

Tests of chemical wood preservatives, poisons for fibre boards and soil poisons. Practically all commercial chemical wood preservatives are being tested in the Gulf States and the tropics to determine their effectiveness in protecting wood from termites. In addition, fibre boards of various types to which poisons have been added during the course of manufacture are under test to determine the chemicals most effective in preventing termite attack; arsenicals and chlorinated phenols appear most promising from tests made during the past several years. Additions have been made to these tests at Saucier, Mississippi, and in Panama in July. Large scale soil poison tests are also under way at Saucier, Mississippi.

PATHOLOGY
(In Cooperation with the Bureau of Plant Industry)

Appalachian

Mimosa Wilt. Greenhouse inoculations of the mimosa tree (Albizzia julibrissin), with several isolates of the Fusarium that causes the wilt, gave definite evidence of the existence of physiologic races of the fungus. In some cases sectors within the same single-spore culture varied in pathogenicity. Certain strains were highly pathogenic to Albizzia julibrissin, A. lophantha, and less so to A. lebbek. None of the strains tested attacked the common native legumes, black locust, honey locust, or redbud. The present known range of the disease extends from Richmond, Virginia, south to Monticello, Georgia, and west to Tryon, North Carolina. The wilt has appeared in a great many new localities this year, and has spread widely within many of the areas where it has been established for a year or more.

Plantation Examinations. In an attempt to form an estimate of disease losses to be expected from planted shortleaf, loblolly, and slash pine in the Southeast, the oldest plantations to be found in North Carolina were visited. Fourteen plantings, ranging from 9 to 50 years old, were examined. In none had disease made serious inroads. The condition of these stands with respect to root and top rot could not be determined because no cutting was done. Localized heavy infections of Cronartium fusiforme comprised the worst disease conditions found. This survey will be extended to South Carolina and Virginia.

Plot Examinations. In none of the following accounts of plot examinations have the data been analyzed. The statements given are, therefore, merely impressions gained from the field work: (1) The amount of sprouting from stumps of oaks cut 4 years ago in northern Virginia has been followed. Those sprouts arising highest on the parent stumps and therefore most likely to become decayed from the parent stumps are usually the dominant sprouts. (2) After 4 years, cross-ties cut from sound wood just above obvious butt rot and, therefore, containing some fungus mycelium, do not seem to be rotting any faster than ties cut from entirely sound trees. (3) Nectria cankered yellow poplars 5 years after release have healed out most of their cankers where the trees were in a condition good enough to respond to release. (4) Data were taken on the effect of heavy thinning 4 years ago on recovery from Nectria canker in western Maryland white oak. The release has had no striking effect on canker healing in this species.

Southern

Native canker forming rusts. A planting of nursery-infested rust-cankered pine seedlings and uninfected or healthy seedlings was made in January 1939 on the Harrison Experimental Forest, Mississippi to compare the survival of nursery-infected seedlings with non-infected seedlings over a period of years. Cankered and healthy slash pine seedlings were obtained from 4 different nurseries. Care was exercised in selecting planting stock. Rust-infected seedlings were definitely cankered and healthy seedlings were free of suspicious swellings.

Survival after three months in the plantation showed that slash pine nursery stock infected with rust suffers greater mortality after planting than uninfected seedlings. Approximately twice as many cankered seedlings died as uninfected seedlings. It is apparent that the difference in survival between the two classes of seedlings will be much greater after the end of the growing season.

Shortleaf pine disease. A diseased condition of shortleaf pine has been found to be widely scattered in central Alabama north of Montgomery and in west central Georgia. Mature shortleaf has been slowly dying with the following symptoms: premature loss of foliage, persistence on the twigs of abnormally short and yellowish needles of the current growing season, death of the branches starting with those closest to the ground and occasionally sucker growth arising from adventitious buds along the larger branches. The cause of the trouble is unknown. Lesions have been found consistently on roots of shortleaf pine trees with these symptoms and intensive laboratory studies are being made in order to obtain a pathogenic organism from diseased root material.

Food of Ambrosia Beetles. In cooperation with the Division of Forest Insects a study of the fungi associated with ambrosia beetles was initiated. What apparently are the food fungi of Platypus, Xyleborus, and Pterocyclon have been isolated but not yet identified. The same fungi were the only ones consistently isolated from the restricted stain areas around the ambrosia beetle tunnels. In a few cases common stain fungi were isolated but in these cases the stain was general in the wood and not of the restricted type characteristic of ambrosia beetle infestations.

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MANUSCRIPTS

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Baker, W. L.	The effect of gypsy moth defoliation on certain forest trees.
Barrett, L. I., and Renshaw, J. F.	Factors affecting cost of producing oak cordwood from culls and portions of trees not utilized for logs. (Submitted to Journal Forestry.)
Buell, J. H.	Red pine in West Virginia. (Submitted to Castanea.)
Byram, George M.	The Appalachian fuel moisture scale. (Submitted to Journal Forestry.)
———————	A plains haze meter. (Submitted to Journal Forestry.)
Jemison, George M.	The influence of section, season, time of day, and year on the visibility of smoke columns. (Submitted to Journal Forestry.)
McQuilkin, W. E.	The natural establishment of pine in abandoned fields of the Piedmont Plateau region. (Submitted to Ecology.)
Minckler, Leon S.	Vegetative competition as related to plantation success in the Southern Appalachian spruce type. (Submitted to Journal Forestry.)
Flood Control Survey	Report on preliminary examination of New River and tributaries, section above Bluestone Reservoir site, for Flood Control. U. S. Department of Agriculture. (June 15, 1939.)

California

Bruce, H. D.	Visibility of a smoke column. (For the U. S. Monthly Weather Review.)
————	Chemical eradication of sprouting stumps. (For Fire Control Notes or Station Research Notes.)
Curry, J. R., and Fons, W. L.	Forest-fire behavior studies. (For American Society of Mechanical Engineers.)
Curry, J. R., Gray, L. G., and Funk, I. C.	Fire danger rating in California. (For the Journal of Forestry.)
Fons, W. L.	Influence of forest cover on wind velocity. (For the Journal of Forestry.)
Mirov, N. T.	Forest Genetics: Present status and future aspects. (For Proceedings of the Pacific Science Congress.)

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LeBarron, R. K.	How black spruce reproduces after forest fires. (For M.A.C. Gopher.)
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Northern Rocky Mountain

Rapraeger, E. F.	Tag ends of the logging and milling study at the White Pine Lumber Company operation at Orofino, Idaho.

Pacific Northwest

Bransford, Loyd, and Kachin, Theodore	Natural pruning in second-growth Douglas fir. (June 15, 1939. Ms.)
Dunford, E. G.	A study of the structure of a Douglas fir forest as it relates to selective cutting. (May 19, 1939. Ms.)
Gross, S. B., and Petersen, W. G.	Progress report on Darrington selective logging plot. (June 6, 1939.)
————————	Progress report on Youngs River selective logging plot. (June 7, 1939.)
Isaac, L. A.	Progress report including record of establishment, Cook Creek selective logging plots 19, 20, and 21. (June 20, 1939.)
Isaac, L. A., and Petersen, W. G.	Report of establishment of selective logging plots on Schafer Bros. sale area. (Permanent plots - Olympic - Nos. 22, 23, & 24; Sept. 28, 1939.)
————————	Progress report on Lake Tahkenitch selective logging plots nos. 1 & 2. (June 5, 1939.)
Munger, T. T., Matthews, D. N., and Furniss, R. L.	The Tillamook fires. (For Loggers Daily.)
Petersen, W. G.	Progress report on Port Orford cedar selective logging plots nos. 1 & 2. (June 2, 1939.)
————————	Progress report on Lake Cushman selective logging plot no. 17. (June 26, 1939.)
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Wilson, S. A.	Rough draft of Digest of Washington's common school laws and related matters with special reference to grade and high schools in rural areas. (May 22, 1939. Ms.)

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Bull, Henry	Forest research in south Mississippi. (For The Mississippi Guide.)
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————————	Studies in raising southern pine nursery seedlings. (For Journal of Forestry.)
Pessin, L. J.	Effect of nutrient deficiencies on young pine seedlings. (For Journal of Agricultural Research.)
Pessin, L. J., and Chapman, R. A.	The behavior of longleaf pine seedlings when competing for moisture and nutrients. (For Journal of Agricultural Research.)
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Canfield, Roy H.	First progress report - Secular trends in semidesert vegetation as influenced by rainfall and semi-deferred grazing. (Included in full in Monthly Report for March, 1938. Not for publication.)

Canfield, Roy H.	Second progress report - Secular trends in semidesert vegetation as influenced by rainfall and yearlong grazing, Jornada Experimental Range. (To Washington Office. Not for publication.)
————————	Third progress report - Secular trends in semidesert range vegetation as influenced by rainfall and fall-winter-spring grazing. (To Washington Office. Not for publication.)
Hendricks, B. A.	Effect of forest litter on soil temperature. (To Washington Office for Chronica Botanica.)
Krauch, Hermann	Development of the Cloudcroft nursery. (To Washington Office for Planting Quarterly.)
————————	Relation of Douglas fir regeneration to seed supply and rodent activity. (To Washington Office for Chronica Botanica.)
————————	Review - Factors affecting establishment of Douglas fir seedlings. (To Jour. of Forestry.)

STATION NOTES

Appalachian

Hursh, C. R.	Outline for compiling precipitation and runoff data from small drainage areas. (Tech. Note 34. August 1939.)
Kellogg, L. F.	"Site index curves for plantation black walnut, Central States Region." Station Note #35. "Site index curves for plantation black locust, Central States Region." Station Note #36.

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Timber supplies, growth, and depletion in the three Lake States. Economic Note No. 11, Lake States Forest Experiment Station. August, 1939.

Field Studies in Selective Logging. Upper Peninsula Experimental Forest, Dukes, Michigan. Lake States Forest Experiment Station. September, 1939.

Southwestern

No. 60. Analysis of a 36-year record of precipitation at Cloudcroft, New Mexico.

61. Comparison of the effects of various kinds of artificial litter upon the germination of grass seeds.

62. First remeasurement of Gila stand improvement plots indicates uniform thinning of ponderosa pine pole stands not desirable.

63. Space requirement of ponderosa pine by tree diameter.

FOREST SURVEY RELEASES

Appalachian

Faulks, E. B.	Forest resources of the northern coastal plain of South Carolina. (Forest Survey Release No. 1. July 15, 1939.)
Hicks, W. T.	Forest resources of the piedmont region of South Carolina. (Forest Survey Release No. 2. Sept, 1, 1939.)

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